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FRIDAY, OCTOBER 8, 1926

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**SCIENCE: A Weekly Journal devoted to the Advancement of Science, edited by J. McKeen Cattell and published every Friday by**

**THE SCIENCE PRESS**

**Lancaster, Pa. Garrison, N. Y.**

**New York City: Grand Central Terminal.**

**Annual Subscription, $6.00. Single Copies, 15 Cts.**

**SCIENCE is the official organ of the American Association for the Advancement of Science. Information regarding membership in the Association may be secured from the office of the permanent secretary, in the Smithsonian Institution Building, Washington, D. C.**

**Entered as second-class matter July 18, 1923, at the Post Office at Lancaster, Pa., under the Act of March 8, 1879.**

## THE PROBLEM OF THE ORIGIN OF SPECIES AS IT APPEARED TO DARWIN IN 1859 AND AS IT APPEARS TO US TO-DAY[1]

*The first of these objects, that is, the establishment of a belief in descent with modification, was always held by my father to be the more important of the two; for I once heard him say, if a recollection of about fifty years' standing may be trusted, that "after all, evolution is the great thing, not natural selection."*—LEONARD DARWIN, "Organic Evolution," pp. 1, 2.

NEARLY one hundred years ago Charles Darwin began to collect facts for "The Origin of Species," his immortal work, which was cautiously withheld from publication until 1859. There still prevailed the zoology of Linnæus and Buffon and the paleontology of Cuvier. In Lesson's "Mammalogie" (1827) the number of mammalian species is exactly 1,124, as compared with the 13,000 species and subspecies of mammals known at the end of the year 1925. Birds increased from 3,600 to 23,939; reptiles and amphibians from 543 to 9,000; fishes from 3,500 to 20,000. Darwin's species stood apart like isolated mountain peaks, whereas to-day living species and subspecies are often comparable to mountain chains composed of lesser peaks completely connected by ridges known as intergradations. It is not the number of species and subspecies which is significant, but the facts as to habit and habitat which are recorded with them. Similarly, it is not the number of fossil species now known as compared with those of Darwin's time, but the *linkage* of families, genera, species, subspecies, and even of "ascending" and "descending mutations" reaching back over hundreds of thousands, if not millions, of years.

This twenty- to one hundred-fold disparity in our knowledge simply intensifies our admiration for the courage of Darwin in boldly substituting a natural for a supernatural conception of the origin of species. It is true that Darwin's most influential authority was not the current zoology and paleon-

[1] Read at the opening of Section D (Zoology) of the British Association, at the Oxford meeting, August 5, 1926. This is the fourth of a series of papers on the origin of species, the first having appeared in *Nature*, June 13 and 20, 1925, under the title, "The Origin of Species as Revealed by Paleontology." The fifth, under the title, "The Origin of Species, V: Speciation and Mutation," will appear in the *American Naturalist*.

tology of his day but Nature itself, whereby even in 1859 he absolutely established the Law of Evolution, as well as the directing and standardizing principle of Natural Selection. It is, however, not this broader aspect of evolution, but the more concrete problem of the *modes* and *causes* of the origin of species which we are considering to-day.

Let us re-examine these causes in the light thrown by naturalists and observers on the invertebrates and vertebrates as distributed over the great continents of Europe and Asia, of North and South America, of Australia, considered not alone with their present boundaries but also with their former land connections secured by elevation to the hundred fathom line. In this connection I present a new zoogeographic and paleogeographic map of the world, prepared with the aid of Bartholomew of Edinburgh. We shall see that the results of zoological and paleontological research are entirely harmonious and concordant, but that zoology, while clearly teaching certain principles of the origin of species, leaves blank many gaps which are completely filled by paleontology.

Thus these two branches of biology are complementary in demonstrating that, through observations after the very naturalistic manner of Darwin in the voyage of the *Beagle* and through the very Lyell-Darwin methods by which the natural origin of species was originally discovered, *the problem of the origin of species has entirely changed in the last hundred years.* In fact, were the great naturalist living to-day, he would be foremost in modifying his own opinions, speculations and theories.

Greatly enhancing the value of the recent work of our field naturalists is the fact that the results reached in fishes, amphibians, reptiles, birds and mammals were recorded entirely independently of each other. Where the conclusions reached are harmonious or concordant they have the convincing value of entirely independent testimony. Also, these results are doubly valuable because they are for the most part assembled without biological purpose or intent, not to prove or to disprove any particular theory, but recorded simply as actual observations.

This is generally true of all field naturalists, who are more concerned about Nature than about the interpretation of Nature. The interpretations upon which our field naturalists do venture, such as the "direct action of environment" and "Lamarckian inheritance," are often lacking in real biological analysis. For such analysis, therefore, we must allude to five biological principles which have developed from laboratory experiments, and the generalizations growing out of them, beginning chiefly in the year 1880. These are as follows:

(1) Weismann's sharp distinction of the germplasm from the body plasm, from which follows the equally sharp distinction between truly germinal specific characters and bodily modifications by environment or habit; (2) the experimental failure of the inheritance effects of adaptive habit, known as Lamarckism; (3) the apparent failure of the environment to modify immediately the germ-plasm in creating adaptive specific characters; (4) the sharp limitations of the originative powers of Natural Selection as conceived by Darwin; (5) the sharp distinction between the continuous and discontinuous (or mutational) origin of specific characters.

In fact, the outstanding speculations of Darwin's and Herbert Spencer's time as to the causation of the origin of species have been pared down by laboratory analysis to a mere vestige of their former selves, and the overweening confidence of one school of causation after another has been displaced by diffidence, doubt, or even agnosticism, as expressed in the final address of William Bateson, whose recent death we lament at this meeting. To sum up, intensive laboratory and experimental research has added vastly to our knowledge of the functions of animals and of the heredity mechanism but has greatly increased the difficulties inherent in the problem of the origin of species. It is the *modes* and the *causes* of the onward progressive movement of the germ-plasm resulting in the consecutive origin of new adaptive specific forms which are rendered still more mysterious by the negative results of laboratory research.

### DISTINCTION BETWEEN SPECIATION AND MUTATION

So far as the *modes* of the origin of species are concerned, these negative results of the laboratory are more than offset by the positive results obtained by our field naturalists and explorers who are independently discovering a considerable number of species-in-the-making at the present time. In other words, we now understand the contemporary origin of species after modes and under conditions wholly unknown to Darwin in 1859. Geographic *isolation,* to which Darwin's attention was first directed by Wagner, with all the incidental influences of physical or chemical change, of enforced change of habit, of competition with a new life environment, perhaps of stimulus to the germinal energies themselves, seems to constitute the chief complex of causes in the origin of new species; this complex is summed up in the principles which Osborn terms *tetraplasy* and *tetrakinesis.* An extreme phase of isolation is *insulation,* where species are scattered among a number of islands. A like isolating mode among fishes is seen in the complete separation of rivers and streams

formerly connected. In this complex of four coefficient causes, all involving energy, the specific germinal substance itself undergoes change, extremely slow but continuous, so that a new stage is very gradually reached, formerly known as a "geographic variation" but now known as a "subspecies." Between subspecies living in islands and separated rivers there are naturally no *intergrades* or intermediate stages, but in a number of independent examples among fishes, amphibians, reptiles, birds and mammals, true intergradation has been observed linking one subspecific form with another in a continuous germinal life-chain. Such survival of intergrades may be instanced as proof of *complete continuity* between subspecies and, consequently, between species.

This appears to be the normal and natural mode of origin of the greater number of specific forms as observed in zoology; such mode has been termed "speciation" by recent British and American authors. In exactly the same field of observation and by the same observers, apparently as an abnormal mode due to some irregular influence on the specific germplasm, is seen the discontinuous or sudden origin of new characters, ranked by some observers as specific, after the manner termed "chance variation" by Darwin and "mutation" by De Vries. *Mutation* thus appears to be a real phenomenon, but a relatively rare one; such mutational origins need to be protected by geographic or climatic isolation from interbreeding with normal species.

Thus *speciation* through continuity stands in contrast with *mutation* through discontinuity. There is no question as to germinal change in mutations, but may the same be said of subspecies? In answer to this doubt it has recently been shown by experiment (Sumner, 1924) that many, if not all, subspecific characters are *stable under changed conditions of environment.* Consequently, while under suspicion as to reality, often vexatious and unconvincing, and always annoying to the systematist, *well-authenticated subspecies are of priceless value to the biologist who seeks to ascertain the conditions under which new species arise.* It proves that many "geographic variations" and "subspecies" are really germinal transitions, intermediates and intergradations from "species" to "species" of the higher kind known to Darwin.

The above is a summary of principles gathered from a very large number of independent observers whose names will be fully recorded with the titles of their papers in the complete series of notes on which the present paper is based. Outstanding names are those of Adams in the gastropods, Jordan, Berg and Regan in the fishes, G. A. Boulenger in the amphibians, E. G. Boulenger in the reptiles, Chapman and Griscom in the birds, Osgood and Sumner in the mammals. The whole list of observers in the vertebrates alone comprises more than a hundred names. For the annotation of this extensive literature I am indebted to members of the corps of zoologists of the American and British Museums and of the Zoological Society of London.[2]

## Examples of Geographic Isolation and Speciation

It appears that speciation arises only where one or all of the energy coefficients of Osborn is changed. In amphibia especially, geographic isolation does not invariably result in the origin of new species, because all the conditions of the new habitat may be identical with those of the old. A most striking example of complete intergradation between "species" is that of the molluscan genus *Io* of the Tennessee River, which now presents all the living intergrades between the smooth and the spinose forms as we pass downstream. In fishes, skeletal intergrades are observed as we pass from northern to southern waters (Berg) or from colder to warmer marine habitats; these intergrades consist in the number of vertebrae, of fin rays and of scales, and in body form and color, and Berg concludes that all the individuals of certain geographic areas simultaneously produce similar new specific characters.

Among amphibians the entire region around the Mediterranean affords G. A. Boulenger a series of subspecies of the edible frog, *Rana esculenta,* more or less connected by intergrading forms. Among reptiles E. G. Boulenger observes the speciation of the skink, *Chalcides ocellatus,* a species which, like the edible frog, surrounds the Mediterranean, in which the difference between two isolated subspecific forms is so great that *were it not for the wonderfully complete manner in which they are connected they could not be denied full specific rank.* As among fishes, intergradations are observed in all the skeletal characters, as well as in the coloring and the scales. Completely supporting these observations are those of many of the recent herpetologists who conservatively use the word "variety" where other authors use the word "subspecies," who imply that intergradations occur wherever a sufficiently large number of specimens is examined. Chapman, with extensive collections of South American birds at his command, records exactly similar results:

> The ornithologist finds large forms occupying colder areas, dark ones humid areas, and pale ones arid areas;

[2] These data will be published in full in a sequel to the present paper, in the *American Naturalist,* No. V in the series on the origin of species.

and as the [environmental] conditions which obviously produce these variations in size and color merge one with the other, so do the [specific and subspecific] forms themselves intergrade. That these variations are inherent [*i.e.*, germinal, constitutional, hereditary] and not merely the temporary impress of physical environment on the individual, is apparently shown by the fact that they are often as well marked in the nestling as in the adult.

Chapman also observes a distinct case of "mutation" within the genus Buarremon in the presence of a black pectoral feather-band, which is established as a specific character by isolation or geographic discontinuity. Like the single case with black dorsal band observed within the genus Troglodytes, the mutation does not intergrade and is thus recognized as of discontinuous or mutational origin. Stresemann finds partial melanism as well as albinism arising as not infrequent mutational characters, but fails to show that these are adaptive. Chapman and Griscom in their North and South American field work distinguish clearly between intergrading and non-intergrading kinds of birds. In a collection of 1,500 specimens of the house wren, Troglodytes, these observers have noted a considerable number of cases of *complete* intergradation between subspecies, and those familiar with the marked physiography of South America, with (*a*) its cold and arid Pacific coastal belt, (*b*) its Andean Mountain chain subdivided by Chapman into numerous vertical life-zones each clearly demarcated until we reach the boreal summits, (*c*) its vast Amazonian forest plain, (*d*) its pampas and plains of the southeast, and (*e*) humid forests bordering the Straits, may anticipate wide speciation in other forms of animal life in this continent. It is noteworthy that these observers have discovered in Troglodytes only one example of mutation in the sense of De Vries. It can not be questioned that isolation is the most important factor in the speciation of birds, especially in its extreme form of insulation.

Among mammals the great transverse geographic range from Scotland across Eurasia and North America of three species of the deer family affords a striking example of geographic speciation: the stag (Cervus) yields twenty-three species and subspecies; the moose (Alces) yields eight subspecies; the reindeer (Rangifer) yields twenty-one subspecies. This is in wide contrast to the knowledge of Darwin (1837–1859), to whom were known only two species of stag, one species of moose, and one species of reindeer. Far more significant, however, are the observations of Osgood and Sumner on the deer-mice of the genus Peromyscus, which range through the temperate region of North America to the Pacific coast. From a collection of 30,000 specimens Osgood finds that a subspecies is characteristic of every distinct climatic region and sub-region. These subspecies listed by Merriam and Osgood have been accepted with great reluctance, especially by naturalists unfamiliar with the excessively sharp geographic and climatic barriers of the western United States. Our hesitation to accept these subspecies as of real germinal or genetic value has been entirely removed by the persistent observations and experiments of the biologist Sumner, largely in the identical collecting grounds of Osgood, and we must welcome these combined observations and experiments as the most convincing demonstration of the principle of *speciation continuity* thus far afforded. Between at least six of these subspecies complete intergradations occur. Classification becomes like dividing the lines of the spectrum. After eight years of transfer from an arid to a humid environment, or vice versa, these subspecies retain their original characters. Even profound change of environment does not yield a new subspecific form, nor are changes of habit inherited in eight years of experiment.

(1) The summary of eight years' experiment proves the comparative stability of subspecies of the Deer-mice (Peromyscus) under very marked new environmental physical conditions. (2) Merriam-Osgood subspecies are proved to be stable under changed conditions of environment, by transplantation experiments; *i.e.*, a desert subspecies, *P. m. sonoriensis*, reared for eight years in a humid environment, is entirely unmodified in the direction of the humid subspecies, *P. m. gambeli*. (3) This doubly proves (*a*) that characters of the desert *P. m. sonoriensis* are germinal, not environmental; (*b*) that humid environment makes no modification whatever toward increased depth of color in eight years and in seven to twelve generations. (4) Similar results from transplantation of *P. m. rubidus* and *P. m. sonoriensis* are obtained: reared in an entirely new environment, they do not converge toward each other or toward the local humid subspecies *P. m. gambeli*.

## SPECIATION A SECULAR PHENOMENON

Whereas an inheritable mutation may be produced by a single experiment, 40,000 years, the lapse of time since the last glaciation, is a moderate estimate of the time required to produce a subspecies. In the case of all the genera cited above—Cervus, Alces, Rangifer, Rana, Chalcides, Troglodytes, Peromyscus—we are observing subspecies arising in a region which was profoundly affected by the fourth glaciation with its pluvial climate, a region in which new subspecies have arisen *pari passu* with the modern demarcations of habitat and of habit. That specia-

tion is an incredibly slow process is attested by the case of the newly discovered Pliohippus of Leidy, which early in Pliocene time assumed all the characters of the modern Equus. The entire speciation process of plants and animals has been going on perhaps for a thousand million years, as estimated on purely physical grounds, and in a recent conversation with Sir Ernest Rutherford it was agreed that another thousand years of research may be required for an understanding of the highly complex physico-chemical basis of life.

### CONCORDANT OBSERVATIONS IN ZOOLOGY AND PALEONTOLOGY

As distinguished from the speciation observed in zoology, in paleontology we deal with secular speciation, in which, quoting from the first of Osborn's series of papers on the origin of species, we observe the adaptive action and reaction of the heredity germ over long periods of time. We also observe the secular action of natural selection (Darwin's selection factor), the secular direct reaction to environment (Buffon's factor), the secular adaptive action of habit (Lamarck's factor), the secular adaptive reaction to the living environment (Darwin's factor). We sharply separate Darwin's factor of selection, which has no energy content, from the above four energetic forces of evolution, namely, heredity, physical environment, living environment, and individual development or ontogeny. These are the principles of tetraplasy and tetrakinesis.

This momentary lapse into speculative as distinguished from purely observational consideration of the problem of the origin of species may clarify the transition from zoology to paleontology.

In paleontology an entirely new series of principles is discovered in speciation which are quite beyond the eye of the zoologist. Chief among these new principles is that dimly perceived by Darwin in the words "analogous variation"; it is that of germinal or evolutionary trend in a definite direction, the "mutations richtung" of Neumayr. Out of this springs Osborn's principle of *rectigradation* observed in the rise of adaptive characters from the germplasm, that is, new specific characters which pass continuously from the most rudimentary and inefficient into the most efficient and highly developed stages. It may be a matter of interest to members of the British Association to recall that this principle was presented to the Association in 1889 by the present speaker. Through unbroken observation during the intervening thirty-seven years this rectigradation principle has been confirmed in four great orders of hoofed mammals, namely, the horses, the rhinoceroses, the titanotheres, and the proboscideans. Research on the two latter groups fills two great monographs aggregating nearly a million words and covering, in the case of the Proboscidea, the analysis of the mode of origin of more than 350 species and, in the case of the titanotheres, the chief stages of specific development extending from Lower Eocene through Lower Oligocene time, when these animals suddenly disappear.

An epitome of these observations is presented in three diagrams in which the three outstanding principles discovered in paleontology are observed: First, the unbroken continuity of speciation, which becomes absolute as the gaps are filled by discovery. Second, the constitutional predisposition to speciate in certain predetermined directions which must be inherent in the germ-plasm of ancestral forms. Third, that these constitutional predispositions are not released except through adaptive reaction to new conditions of life; they are not, therefore, of the nature of inherent perfecting tendency, but, rather, of the nature of a *potentiality* to appear when the need for them arises. For example, the rhinoceroses have the potentiality of developing two horns, an anterior horn on the nasal bone and a posterior horn on the frontal bone. But in the fourteen branches into which this great subfamily subdivides in its migrations to all parts of the earth, this double potentiality is seldom availed of, sometimes not availed of at all.

### CONCLUSIONS

We seem to have reached an entirely new era in research on the problem of the origin of species, marked by the decline and death of speculations and theories advanced upon the very limited knowledge of the first half of the nineteenth century. Through zoology and paleontology we have reached a solution of the least difficult half of the problem with which Charles Darwin was confronted: we know the *modes* by which subspecies and species originate; in fact, there is little more on this point to be known. But this very knowledge renders the problem of *causes* infinitely more difficult than it appeared to Darwin. The causes of "variation," to use the term he employed for the evolutionary process, lie in the way before us. They may be resolved or they may prove to be beyond human solution. We must resolutely face these alternatives, and in the meantime continue our synthesis over every field of biologic research.

HENRY FAIRFIELD OSBORN

## THE JOURNAL "SCIENCE" AND THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

AT the April, 1925, meeting of the executive committee of the council of the American Association for the Advancement of Science, the editor and owner of SCIENCE offered under certain conditions to let the journal, which since 1900 had been the official organ of the association, become its absolute property. The plan was approved by the executive committee, which unanimously voted "its sincere and hearty thanks to Dr. Cattell for his most generous offer." The agreement was put in contractual form by Dr. Roscoe Pound, dean of the Harvard Law School, one of the most distinguished fellows of the association, originally elected for his contributions to botany. The contract was executed by the owner of SCIENCE and Dr. Pupin, president of the association, and attested by Dr. Livingston, permanent secretary, on July 28, 1925. It was approved by a unanimous vote of the council of the association on December 30, and a committee, consisting of Drs. Pupin, Kellogg and Livingston, was appointed to express to Dr. Cattell the appreciative thanks of the association. The full text of the agreement is as follows:

*This Agreement* made and entered into this 25th day of July, A. D. 1925, by and between James McKeen Cattell, of Garrison-on-Hudson, in the state of New York, and the American Association for the Advancement of Science (hereinafter referred to as the Association), a corporation organized and existing under the laws of the Commonwealth of Massachusetts.

*Witnesseth:*

*Whereas* at the regular spring meeting of the Executive Committee of the Association, held in the city of Washington, in the District of Columbia, on or about the twenty-fifth day of April, 1925, the said Cattell presented to the said Association a memorandum of offer with respect to the acquisition of the weekly journal devoted to the advancement of science, edited by the said Cattell and known as SCIENCE, which memorandum was in the words and figures following, to wit:

> "It is agreed and contracted between the American Association for the Advancement of Science, incorporated in the state of Massachusetts, and James McKeen Cattell, of Garrison, New York, that on the death of the latter or on his relinquishment of the control of the weekly journal SCIENCE for any cause, the journal shall become the absolute and unencumbered property of the Association on the following conditions, namely: (1) That the present arrangement between the Association and the journal, or some other arrangement adopted by mutual agreement, is at the time in effect; (2) that should Josephine Owen Cattell (who for over thirty years has cooperated in the editorial and business conduct of the journal) survive the acquirement of the journal by the Association, she shall be paid annually during her life one-half the average annual net profits of the journal during the five years preceding its acquirement, and (3) that the arrangements for editing, publishing and printing the journal in effect at the time of the acquirement of the journal by the Association shall be continued so long and in so far as this is consonant with the interests of the Association."

*And whereas* upon consideration of said memorandum of offer the Executive Committee of said Association, duly empowered in that behalf, unanimously approved of the proposals of the memorandum and authorized the President and Permanent Secretary of the said Association to enter into a contract and agreement with the said Cattell accordingly, and unanimously voted its sincere and hearty thanks to Dr. Cattell for his most generous offer.

*Now therefore* it is hereby covenanted and agreed by and between the parties aforesaid as follows:

1. The said Cattell agrees that should he at any time relinquish the control of the said journal for any cause he will in consideration of the several covenants and agreements of the said Association hereinafter set forth make over and convey said journal, the good-will thereof, and all things thereunto appertaining to the said Association, so that the said journal shall become the absolute and unencumbered property of the Association, subject, however, to the conditions hereinafter set forth.

2. Said Cattell further agrees in consideration of the several agreements and covenants of the said Association hereinafter set forth that should he, the said Cattell, retain control of said journal down to the time of his death, his personal representatives within a reasonable time after his decease shall make over and convey said journal, the good-will thereof and all things thereunto appertaining to the said Association, so that the said journal shall become the absolute and unencumbered property of the said Association, subject, however, to the conditions hereinafter set forth.

3. In construing the foregoing paragraphs, accounts payable but not yet due, and subscriptions not yet filled, shall not be deemed encumbrances. On taking over the said journal said Association shall take over all outstanding accounts due to the journal, and shall be liable for all outstanding obligations, but the payments of the Association on account of subscriptions of the members by virtue of any contract or arrangement then existing between the Association and said Cattell shall be pro rated so that the Association shall receive its proportional share of any subscriptions paid in advance.

4. The said Association in consideration of the foregoing covenants hereby agrees and covenants to and with the said Cattell that in case Josephine Owen Cattell (who for over thirty years has cooperated in the editorial and business conduct of the journal) should survive the acquirement of the journal by the said Association, the said Association shall pay or cause to be paid to her annually in quarterly installments during her life a sum

equal to one half of the average annual net profits of the said journal earned during the five years next preceding its acquirement. The amount of such profits shall be determined from the books of account kept and used in the business of conducting said journal, provided, however, that should any dispute or controversy arise as to the amount of such profits, such dispute shall be submitted to arbitration by three arbitrators, one to be appointed by the said Cattell, or his personal representative, one by the said Association, and a third by the arbitrators so chosen, and it is hereby covenanted and agreed that the arbitration of such controversy or dispute by said arbitrators or a majority thereof shall be final and binding upon the parties hereto and their representatives.

5. The term "average net profits" in the preceding paragraph shall be construed to mean the average excess if any of receipts of said journal from all sources over and above the cost of printing and publication thereof. But the cost of publication shall not include any payment for the time given to the journal by said James McKeen Cattell or said Josephine Owen Cattell, and in estimating the cost of publication the outlays of the Science Press for office rent, business management, and like overhead expenses, shall be pro rated in proportion to the expenses of the several publications published by said Press, and the proportion thereof chargeable on that basis to said journal SCIENCE shall be deemed part of the cost of publication thereof.

6. The said Association covenants and agrees to continue the arrangements for editing, publishing and printing the said journal which shall be in effect at the time said journal is acquired by the Association under the terms hereof for a reasonable time after such acquisition, and so long and in so far thereafter as is consonant with the interests of the said Association.

7. The covenants and agreements heretofore entered into by the said Cattell are made and entered into subject to the following express condition, to wit, that at the time of relinquishment of control of said journal by said Cattell, or if he shall be in control thereof at the time of his death, then at the time of his death the present arrangement between the said Association and the said Cattell or some other arrangement adopted by mutual agreement shall be in effect.

*In witness whereof* the said Cattell has signed and sealed these presents, and the said Association has caused these presents to be signed by its President and attested by its Permanent Secretary, and has caused its corporate seal to be thereunto affixed the day and year first above written. Executed in duplicate.

JAMES MCKEEN CATTELL

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

M. I. PUPIN,
*President*

Attest:

BURTON E. LIVINGSTON,
*Permanent Secretary*

Witness:
RODNEY H. TRUE
JOHN KAYGANOVICH

SCIENCE was established in 1883 by A. Graham Bell with the cooperation of Gardner G. Hubbard, the father of Mrs. Bell. The telephone was patented in 1876, and seven years later Mr. Bell wisely and generously used part of the profits from that great invention to found a weekly journal of science. There were at that time but few scientific journals in the United States. *Silliman's Journal,* established in 1818, occupied a historic position, but had become special and limited in its scope. The *Scientific American,* first published in 1846, was concerned chiefly with invention and popular technology. *The American Naturalist* had been founded in 1867 by A. S. Packard, E. S. Morse, Alpheus Hyatt and F. R. Putnam. The *Popular Science Monthly* had been established in 1872 by Dr. W. T. Youmans and the Appletons. We had no publication of the general type of *Nature,* founded in England in 1869.

There had been published in New York during 1881 and 1882 a weekly devoted mainly to physical science and invention entitled *Science,* and Mr. Bell purchased from Mr. John Michels for $5,000 the title and good will of this journal. Continuity of publication was not, however, maintained, and the present journal dates from 1883. Mr. Thomas A. Edison had been responsible for the foundation of the earlier *Science.* He wrote in 1925: "If you will look back at your earliest records, you will find that SCIENCE was originally started and financed by me, and was published for about a year, when I withdrew. . . . When I could not finance the publication further, I paid his [the editor's] salary in full and told him he could have the paper and do what he pleased with it." We thus owe the establishment of a weekly journal of science to the two American men of genius who have done the most for the applications of science to human welfare.

The ownership of SCIENCE was vested in The Science Company, organized under the laws of Massachusetts, with a capital of $25,000, most of which was contributed by Mr. Bell and the balance by Mr. Hubbard. The directors, in addition to Mr. Bell and Mr. Hubbard, were Daniel C. Gilman, president of the Johns Hopkins University, who was president of the company; Othniel C. Marsh, of Yale University, and Samuel H. Scudder, president of the Boston Museum of Natural History. There were later added to the board Simon Newcomb, of the Nautical Almanac; J. W. Powell, of the U. S. Geological Survey, and W. P. Trowbridge, of Columbia University. Mr. Scudder, the distinguished entomologist, who lived at Cambridge but was not connected with Harvard University, was the editor. The publisher was Moses King, and the first number was issued at Cambridge on February 9, 1883.

This number contains a short contribution by S. P. Langley on photographing the corona without an eclipse and longer articles on a meteor and on a typhoon. There is a review by Asa Gray, followed by correspondence and notes, including abstracts of recent contributions to science. The second number opens with an appreciation of Henry Draper by Charles A. Young and contains articles by Dr. Ira Remsen and H. Newell Martin. In subsequent issues and volumes will be found contributions from nearly all Americans who have led in scientific research.

SCIENCE was issued in editions of from six to ten thousand and attained a subscription list of about 1,500. It was, however, found difficult to obtain advertising. The publication was far from self-supporting and Mr. Bell and Mr. Hubbard contributed in all over $80,000 for its maintenance during the early years. Mr. Scudder retired from the editorship in 1885 and was succeeded by N. D. C. Hodges, the office of publication being removed from Cambridge to New York.

The journal continued to maintain good scientific standards, but there were financial difficulties, and the ownership was transferred to Mr. Hodges, though Mr. Bell continued to assist with gifts. In 1887 the page was changed to a large quarto size and the journal became less satisfactory to scientific men. Mr. Hodges used all possible efforts to secure the cooperation of some educational institution or scientific society. At its meeting in 1893 a subsidy of $750 was voted by the American Association for the Advancement of Science and Mr. Bell agreed to give $500. It might or might not have been better if at that time the American Association had been prepared to acquire the ownership of SCIENCE. Mr. Hodges found it impossible to continue the journal, and publication was suspended with the issue of March 23, 1894.

SCIENCE was purchased from Mr. Hodges by the present owner and editor in 1894, and publication was resumed on January 4, 1895, all unexpired subscriptions being filled. An editorial committee, representative of the several sciences and of different institutions, was formed consisting of S. Newcomb, mathematics; R. S. Woodward, mechanics; E. C. Pickering, astronomy; T. C. Mendenhall, physics; R. H. Thurston, engineering; Ira Remsen, chemistry; Joseph Le Conte, geology; W. M. Davis, physiography; O. C. Marsh, paleontology; W. K. Brooks, invertebrate zoology; C. Hart Merriam, vertebrate zoology; N. L. Britton, botany; Henry F. Osborn, general biology; H. P. Bowditch, physiology; J. S. Billings, hygiene; J. McKeen Cattell, psychology; Daniel G. Brinton, J. W. Powell, anthropology. To this committee in order to cover the medical sciences and to fill vacancies caused by death (there have been no others) there were later added Charles D. Walcott, geology; C. S. Minot, embryology; L. O. Howard, entomology, and William H. Welch, pathology. Subsequently, the vice-presidents of the American Association for the Advancement of Science and still later members of the executive committee of the council were made members of the editorial committee. As a matter of fact the responsible editor has had the cooperation of practically all American men of science.

The first number of the new series of SCIENCE opens with introductory articles by Simon Newcomb and D. C. Gilman and there are contributions by Daniel G. Brinton, then president of the American Association; G. Brown Goode, T. C. Mendenhall, J. W. Powell, C. Hart Merriam, Samuel H. Scudder, R. S. Woodward, A. S. Packard, H. W. Conn and N. L. Britton. The editorial standards of the first number have been maintained to the latest issue.

The subsidies promised by the American Association for the Advancement of Science and by Mr. Bell to Mr. Hodges were paid during the first year, but no gifts or subsidies have since been received or sought. As may be supposed the financial conduct of the journal was by no means easy and it has only become self-supporting in recent years. In this connection acknowledgment should be made to the printers, The New Era Printing Company of Lancaster, Pa., and especially to Mr. Andrew Hershey. In 1893 they were printers of a local newspaper and of local job work. They offered terms much lower than any city printers and maintained the same rates for SCIENCE for twenty-five years. They proved themselves to be excellent printers and in 1920 were printing some fifty scientific journals. After one partner had died and the other two had advanced in years, the business was sold to a promoter, not himself interested in printing. Charges were greatly increased and the printing became less efficient.

Efforts were made to purchase the printing plant with cooperative ownership by the scientific journals that it printed, but these failed, partly because the $300,000 asked included at least $100,000 for the good will in large measure given to the business by SCIENCE, and partly owing to the difficulties of ownership by the societies and institutions that controlled the journals. When the Carnegie Institution was established in 1902, the editor of SCIENCE proposed the organization by it of an office for scientific printing and engraving which could have been made self-supporting, and, as in the case of the Oxford and Cambridge presses, would have rendered valuable service by assured continuity and expertness in scientific printing; but the plan was not adopted.

SCIENCE and the other journals of The Science Press were for a time printed in Utica, N. Y. In 1923 The Science Press Printing Company was incorporated with its office at Lancaster and with the cooperation of Mr. A. E. Urban as general manager and of those compositors, pressmen and proofreaders who had given that city distinction as a center for scientific printing. This company is now responsible for printing SCIENCE and a considerable number of other scientific journals, monographs and books.

Space is given here to the question of printing, for, while there is now discussion of the economic control of history, most scientific men may not realize the difficulties involved in printing and publishing a scientific journal. The editorial contents are open pages for commendation or criticism, and that may seem to be the whole story. Business men who control newspapers and magazines have more information and a different attitude. As much time has been given to the publication and printing of SCIENCE as to the editorial conduct, and the work has been more difficult and more irksome.

During 1895 SCIENCE was published at Lancaster, Pa., and Garrison, N. Y., with an office at 41 East Forty-ninth Street, New York, which was then the address of Columbia University. From 1896 to 1907, inclusive, the journal was published by The Macmillan Company, who assumed the cost in view of the value to them of the advertising space. It is, however, difficult for a large publishing company to publish a journal that it does not own; in 1908 the publication was taken over by The Science Press, a registered trade name. Scientific men should realize their obligations to The Macmillan Company, as well as to The New Era Printing Company, for maintaining the publication of a weekly scientific journal under difficult economic conditions.

In 1900 SCIENCE became the official journal of the American Association for the Advancement of Science. The agreement was made at the summer meeting in New York City by a committee consisting of Simon Newcomb, G. K. Gilbert, R. S. Woodward, James Lewis Howe and L. O. Howard, who had recently been elected permanent secretary of the association. By the arrangement SCIENCE published the official notices and proceedings of the association and was sent to members in good standing at a cost to the association of $2 each. The annual dues of the association were $3, and no increase was necessary owing to the ever enlarging membership of the association through the arrangement with SCIENCE and to the admirable conduct of its affairs for more than twenty years by Dr. Howard, followed by the notably successful administration of Dr. Livingston.

The subscription price of SCIENCE was $5 and most subscribers naturally became members of the association, which then began the growth in membership and influence which it has since maintained. The book membership at the beginning of 1900 was 1,721, but the names had been kept on the rolls of those who had not paid their dues for years and the actual membership was about 1,200. The largest recorded membership had been 2,033 in 1883, after which there had been a gradual decline, not checked even by the Boston anniversary meeting of 1898 with an attendance of 903.

Within two years after the arrangement by which SCIENCE was sent to members of the association the membership more than doubled. In 1909 it had increased to over 7,500; it is now about 14,000. SCIENCE also profited on the editorial side, for it was a great advantage to have more readers, the subscribers now numbering about 11,000, and the total number of readers being much larger. It does not, however, follow that the financial situation of the journal was improved. It is perhaps sometimes taken for granted that SCIENCE is supported by the association; it would be equally true to say that the association is supported by SCIENCE, the journal having always been supplied to members at considerably less than the actual cost of printing, paper and postage. The expenses of publication have been met by libraries and other subscribers who paid the regular rates and by advertisements.

The financial gain to the journal has been in the increase in the value of the advertising space from the larger subscription list, but it is difficult to obtain advertising for a journal with a limited circulation and without an organized advertising department, so there was not a great deal of advertising and it was necessary to charge it nearly at cost. The situation, however, changed at the end of the war, when for various reasons advertising increased everywhere, and the president and trustees of Columbia University had made it feasible for more time to be given to the business conduct of the journal. Not only SCIENCE, but also those who read it and even those scientific men who may not read it but none the less profit from its existence, are under real obligations to the advertisers who make its publication possible. The advertisements are a matter of business, more profitable it may be hoped to the advertisers than to the journal, but none the less they are thus cooperating with scientific men in advancing their common interests, which are also the interests of the nation. Many subscribers have expressed the opinion that they find the advertising pages one of the most interesting and useful departments of SCIENCE.

The cooperation between the American Association and SCIENCE has certainly been a benefit to scientific organization. There has been no increase in dues to

members, except from $3 to $5, to make up for the depreciated dollar, the journal since 1920 receiving $3 for each subscriber, an increase of 50 per cent. to meet increased costs of printing, paper and postage of about 100 per cent. If SCIENCE is compared with *Nature,* the *Revue Scientifique* or *Naturwissenschaften,* it should be remembered that the subscription rates of these journals are much higher. SCIENCE certainly need not shun comparison with the French and German weeklies; in the case of *Nature* the domestic subscription rate is £2.12, about $12.60. As prices in general are lower in England than here (wages and salaries being about two thirds) the cost of *Nature* is relatively at least five or six times that of SCIENCE. This makes it possible to issue a journal about 50 per cent. larger and to pay adequately for editorial conduct and contributions, but it may be doubted whether American men of science would care to pay $15 to $18 for a weekly journal, and the smaller circulation would be a serious drawback to its usefulness.

In 1909 members of the American Association were given the option of receiving by request *The Popular Science Monthly,* now *The Scientific Monthly,* in place of SCIENCE. This was a serious disadvantage to SCIENCE, as its circulation was decreased and the advertising space made less valuable. It also involved a financial loss to the *Monthly,* as subscribers became members of the association without expense to them, but at the cost of the journal, and there were practically no advertisements in it to gain by an increased circulation. However the circulation of *The Scientific Monthly* is now over 9,000 and efforts are being made this year to obtain advertisements. The option was doubtless useful to the association as it increased the membership and gave those who wanted it a less technical magazine and one that might be read at home or placed in the office by those who have access to SCIENCE in a library, club or laboratory. In many instances husband and wife or father and son are or might be members of the association and would not want two copies of the same journal.

There has been discussion of a magazine for members of the association still more popular in character than *The Scientific Monthly,* but unless there were a very large increase in membership it would not be feasible to give such low rates with alternatives among several journals. It appears also that it would scarcely be desirable for the association to enter on the difficult undertaking of a magazine more popular in contents than the lectures and general interest sessions of the annual meetings. If such a magazine is feasible it lies in the field of Science Service, an endowed institution for the popularization of science, a majority of whose trustees are nominated by the American Association, The National Academy and the National Research Council.

A number of leading American scientific journals have been established and conducted under private auspices and have become later the publications of national scientific societies. To mention only the most recent instance, the *Psychological Review* and its associated publications, established by Professor J. Mark Baldwin and the present editor of SCIENCE in 1894, have this year become the property of the American Psychological Association. It has always been the hope of the editor and owner of SCIENCE that, in the interest of the journal, of the American Association for the Advancement of Science and of science in America, the journal should ultimately be owned and conducted by the association. This is assured by the contract here printed.

In reference to the reservation of an annuity to Mrs. Cattell in case she should survive the transfer of the ownership of SCIENCE to the association, it should be made clear that this is only a small return for invaluable services, not in any sense a gift either from the association or from the present owner. Although there were seven children, none of whom had a nurse or governess or attended school until he went to college, Mrs. Cattell has devoted some ten hours a day, not excepting Sundays, to the editorial and business conduct of SCIENCE and of other publications later acquired or established. The situation is fortunately such that the larger the annuity, the more readily can it be paid by the association and the greater the value of the property that it acquires without other cost.

The editor of SCIENCE has by force of circumstance led a multiple life; in consequence he has done nothing so well as he would have liked. He may look back with regret to the paleontological era when he was able to give ten hours a day to psychological experiments, for there is no sport more absorbing than scientific research. But the advancement of science is not only a fascinating game of commingled skill and chance; it is the greatest single factor in promoting human welfare. It is the business of the scientific man to contribute to the progress of science in the way that he best can. Under modern conditions the miner can dig up the gold only as the result of a complicated organization both before and after. The gold is only of value when it is put to use. Freedom of research and teaching, the intellectual, personal and economic integrity of the man of science and the teacher, must be maintained at any cost to the individual. Fortunately efforts on their behalf are one of the few undertakings that is nearly as interesting as scientific research.

For two years, beginning in the summer of 1924, the editor's eldest son, Dr. McKeen Cattell, while engaged in physiological teaching and research, assisted in the editing of SCIENCE, thus permitting the editor to attend as president of the American Association the meeting of the Pacific Division and later to spend two months in Europe. Otherwise he has not been absent from the office (though on several occasions it moved with him) for a longer interval than about a week and then only to attend scientific meetings. The editor made up every issue of the journal for thirty years, obtained most of the articles printed, decided on the disposition of every manuscript submitted, and prepared practically all the notes. As there was no possibility of paying for contributions the undertaking has not been easy. The contents of the journal may not always have been as interesting or as timely as would have been desirable, but the editor hopes that they have maintained high scientific standards, freedom of speech with decency of expression and impartial treatment of institutions and individuals. SCIENCE is perhaps the only publication in any country that may be regarded as a professional journal for scientific men as a class. Perhaps the chief satisfaction of the editor is that he has never had the slightest personal controversy or difficulty with any one of the thousands of scientific men with whom there have been relations. He especially appreciates their unanimous support of SCIENCE at a time when his views on war and conscription were not shared by most of them, and when the president and trustees of Columbia University made charges as serious as they were absurd.

The editor of SCIENCE has personally small use for charity or philanthropy. These may be needed as temporary expedients, but it would surely be better if scientific men could conduct their researches, their institutions and their publications as masters of the situation rather than as suppliants for aid. Only enlightened selfishness is involved in the transfer of SCIENCE to the American Association. The father wants his child to be cared for when he can no longer look after it himself. Although the editor of SCIENCE is but one of fourteen thousand members of the American Association, it and its objects have long been one of his chief interests, he being chairman of the executive committee of the council and having been a member of this committee and of its predecessor, the committee on policy, for twenty-five years. He has devoted his life in the main to the objects that the journal and the association are there to promote and he is thus doing the best he can to preserve SCIENCE for his enduring self.

These remarks are printed after hesitation and with reluctance. If there is any one who is familiar with the some 50,000 pages of SCIENCE issued in the course of the past thirty-two years, he can bear witness to the fact that personal references and appeals for aid have been lacking. The only excuse that can now be offered for a departure from this policy is that a psychologist and an editor knows the risk of leaving an obituary notice to others.

However these things may be, we may hope that the contract according to which SCIENCE will be owned and conducted by the American Association for the Advancement of Science will ensure a good journal of science and an influential association of scientific men. Both the journal and the association are means to an end, namely, the advancement of science, which is the most fundamental concern of modern civilization. Under the circumstances it may be reasonable to look not only for the continued cooperation of scientific men, but for their united efforts in the editorial and financial support and betterment of a journal that belongs to them.

J. MCKEEN CATTELL

## THE RELATION BETWEEN THE COST OF RESEARCH AND THE COST OF PUBLICATION

As chairman of the sub-committee on publication of the Committee of One Hundred on Research, of the American Association for the Advancement of Science, it has occurred to me that it might be of interest to find out approximately the relation between the amounts spent for research and the cost of the publication of the results. For this purpose I addressed a letter to each author of a paper in the *Journal* of the American Chemical Society or in *Industrial and Engineering Chemistry* for the April issues of the current year, asking for an approximate estimate of the cost of the article, including:

(a) That portion of your salary during the period when you were working on the research, which you think may fairly be charged as a part of the expense of the preparation of the article.

(b) Any special expense incurred for equipment or materials.

(c) The proportional part of the cost of the upkeep of your laboratory which might reasonably be charged as a part of the cost.

The response has been very cordial and general. Twenty authors of papers in each journal gave me their estimates:

For the *Journal* of the American Chemical Society the estimates covered 172 pages, with a total of $26,138. This is $152 per page.

For *Industrial and Engineering Chemistry* the estimates covered 151 columns, with a total of $46,352, or $307 per column.

The estimates varied from $5.50 to $540 per page for the *Journal* of the American Chemical Society and from $20 to $4,000 per column for *Industrial and Engineering Chemistry*.

Evidently such statistics must not be pressed too far, but it seems probable that the totals and averages are rather below than above the actual costs.

From the treasurer's report for 1925, the *Journal* contained 3,190 pages and cost $46,578.50, or about $14.60 per page. *Industrial and Engineering Chemistry* contained 2,636 columns and cost $72,006, or about $27.30 per column.

The inquiry was made whether the space allowed to the author was adequate for the proper presentation of his results. Fourteen authors of articles in the *Journal* of the American Chemical Society desired more space and five authors of articles in *Industrial and Engineering Chemistry*. It is evident that the need of additional funds for publication is felt much more keenly by writers for the former journal. It can scarcely be questioned that articles which will have a far-reaching and permanent effect on the development of our science are more likely to appear in that *Journal* and that the authors, as a class, receive less adequate remuneration for their work.

On the average, an interval of 4.1 months elapsed between the receipt of an article by the editor of the *Journal* of the American Chemical Society and its publication. The interval for *Industrial and Engineering Chemistry* was, on the average, 2.3 months. For the latter journal very few articles were held more than two months, and little improvement could be expected for a monthly journal.

Delays are due chiefly to three causes:

(1) Inadequate funds for the publication of all suitable material submitted. The delay could be remedied during the first eight or nine months of the year by sending to the printers, each month, all articles that are ready and publishing smaller numbers during the last months of the year, if the budget requires this. It costs no more to publish an article at one time of the year than another and every one desires prompt publication.

(2) Necessity of returning articles to authors to be shortened. The remedy for this is partly in the hands of the authors. Undoubtedly some articles are improved by a briefer presentation. There is a very general feeling, however, that the abbreviation has been carried too far. So far as this is true, the only remedy is additional funds for publication. It is very evident that these are urgently needed. In spite of the rigid limits for space set by the editors, our authors evidently prefer the large circulation given to articles published in our journals to the more adequate space permitted by journals of a more limited circulation.

(3) Delay of papers in the hands of associate editors. This has very likely been aggravated by the feeling on the part of these men, all of whom are busy and serve without compensation, that the publication will be delayed for the first reason and prompt return of a paper is unnecessary. Such delays should, of course, be made as short as possible.

We seem justified in the conclusion that contributors to the journals of the American Chemical Society furnish, free gratis, articles which have cost for their preparation at least ten times the sum required for their publication. The prestige of the journals depends on the excellence of the articles contributed to them, and we are in no position to pay for them even a small fraction of what they have cost. In *Industrial and Engineering Chemistry*, especially, authors and firms often hesitate to publish material which may be of value to their competitors, and the public is under great obligation to those who have the wisdom to see the advantages to be gained from cooperation. We certainly owe to these authors and to the institutions and firms which they represent more adequate and prompt publication than they now receive. How can this be secured? It is very poor economy for us to promote research, as we are now doing, and refuse to furnish the means of making the work that is done of value to the world.

WILLIAM ALBERT NOYES
URBANA, ILLINOIS

## THE FIRST GREENLAND EXPEDITION OF THE UNIVERSITY OF MICHIGAN

THE expedition has returned safely after spending nearly nine weeks exploring in Southwest Greenland. The *Morrissey*, on which transportation was secured for the expedition both to and from Greenland, is an 83-ton schooner with auxiliary power commanded by Captain Robert A. Bartlett and chartered by the expedition of the American Museum of Natural History directed by George Palmer Putnam.

The *Morrissey* ran upon an uncharted reef near Cape York and sustained very serious injury to her bottom, including the loss of a part of her keel. In a leaking condition the *Morrissey* left Holstenborg with the Michigan party on September 7th and the second day out lost her propeller. Thus badly crippled, after reaching the Straits of Belle Isle she encountered a series of moderate gales from the southwest which continued for five days, during which she made very little advance. These gales were succeeded by a full gale from the northeast before which she ran and reached North Sydney, Nova Scotia, on September 23rd.

The Michigan Expedition was directed by Profes-

sor William H. Hobbs and included Professor Laurence M. Gould, assistant director, geologist and photographer; Mr. S. P. Fergusson, U. S. Weather Bureau, meteorologist and upper-air expert; Professor J. E. Church, Jr., meteorologist; Mr. Ralph L. Belknap, surveyor and geologist; and Mr. P. C. Oscanyan, Jr., radio operator.

The base of the expedition was established on July 7th at Camp Little on the shore of the Maligiak Fiord, about fifty miles east of Holstensborg, where a meteorological station was at once set up and balloon work undertaken. In all, some ninety pilot balloon ascensions were made and followed with the theodolite to an average height of about 7,000 meters. Many were followed to 10,000 meters, and one to about 14,000 meters.

Ballons-sondes, making use of the new Rosby deflating device, were sent up and in three instances the meteorographs which they carried were recovered with records intact after reaching, in one case, a height of 1,500 to 2,000 meters. In two cases planned for greater heights, though the device seemed to operate, the balloons were lost; but almost miraculously one of the meteorographs was later recovered intact after having reached the extreme height of 8,000 meters. No ascensions by ballons-sondes have hitherto been carried out in Greenland.

An exploring party consisting of Hobbs, Gould, Church and Belknap with four Greenlanders traveled by umiak, canoe and on foot and reached the margin of the inland-ice about one hundred miles east of Holstensborg. The entire journey occupied twenty-two days and was shortened by the failure to find game in the interior region. The inland-ice in this district presents an unusually gradual ascent and a way of penetrating it was found without great difficulty.

Pilot balloons were sent up from the margin of the inland-ice and followed with the theodolite to a maximum height of 5,500 meters. Others were sent up from above the ice itself and were followed *over its surface throughout* to a maximum height of 2,000 meters. These ascents are the first ever to have been made at such positions either in Greenland or the Antarctic.

Psychrometer and wind observations were carried out by Professor Church at three-hour intervals both day and night during the twenty-two day journey. Self-registering instruments loaned by the U. S. Weather Bureau have been left with Governor Bistrup at Holstensborg, who has arranged to have them read regularly throughout the coming year. Observations with a tide-gauge, loaned by the U. S. Coast and Geodetic Survey, have been regularly made at Camp Little. A triangulation survey of an area of about 1,000 square miles of rugged territory has been carried out by Mr. Belknap, and in all a score of mountain peaks having altitudes up to 4,300 feet have been occupied as stations. Glaciological studies have been carried out by Professor Hobbs, and a study of raised beaches by Professor Gould.

The first short-wave wireless station to be erected away from the immediate coast of Greenland has been established for the period of occupation at Camp Little. Messages were received from American, European and South American stations, as well as from Australia and New Zealand; and much has been learned concerning the suitable conditions for operation at such stations.

This expedition is preliminary only to that planned for 1927. A depot of equipment was therefore laid down at the margin of the inland-ice, and arrangements were completed to have pemmican and other supplies taken in to the same depot by dog-sled during the coming winter.

WM. H. HOBBS

UNIVERSITY OF MICHIGAN

## SCIENTIFIC EVENTS

### STATISTICS OF THE PHYSICIANS OF GERMANY IN 1926

ON the basis of the popular Reichs-Medizinal-Kalender, which, under the editorship of Prof. Julius Schwalbe, appeared again this year, for the first time since the outbreak of the war, Prinzing of Ulm, well known as a medical statistician, has published in the *Deutsche medizinische Wochenschrift* statistics on German physicians which are quoted in the *Journal* of the American Medical Association. The total number of physicians in Germany, with a population of 63,000,000, is 45,000, or 7.1 physicians to each 10,000 inhabitants. In 1913, the number of physicians was 34,000, or 5.2 to each 10,000 inhabitants. The highest percentage of physicians is found in the three cities Hamburg, Bremen and Lübeck (from 10.5 to 10.8 per 10,000 population); then follows Hesse-Nassau with 9.3. In Berlin there are 229 gynecologists, 248 surgeons, 145 ophthalmologists, 174 otorhinolaryngologists, 381 dermatologists and venerologists, 66 specialists in gastro-intestinal affections and diseases of metabolism, 177 neurologists and psychiatrists, 16 lung specialists, 147 pediatricians and 318 specialists in miscellaneous branches of medicine. In each hundred physicians in Greater Berlin, 34.5 are specialists, and for each 10,000 inhabitants there are 13.7 general practitioners and 4.5 specialists. The total number of physicians in Greater Berlin is 5,513, and the total number of dentists is 1,121. There has been a marked increase

in the number of woman physicians throughout the country. In 1913, there were only 195, while now there are 1,627, of whom 230 are assistants or "volunteers." There are 1,397 who have an independent private practice. Women physicians appear to prefer the large cities, in the main. In Greater Berlin alone there are 314; in cities of more than 100,000 inhabitants there are 565; in cities with from 50,000 to 100,000 inhabitants, 125; in cities with from 10,000 to 50,000 inhabitants, 196; in cities with from 5,000 to 10,000 inhabitants, 63, and in communes with less than 5,000 inhabitants, 134. In the small rural communities one finds very frequently women physicians who are married to physicians. In communities with less than 5,000 inhabitants, of 134 women physicians sixty-four were married to physicians. Women physicians are, for the most part, general practitioners. However, 116 are pediatricians and forty-three are gynecologists, while twenty-eight are specializing in both pediatrics and gynecology. There are twenty-eight women ophthalmologists, twenty-seven dermatologists and venerologists, fifteen neurologists, six surgeons, two otorhinolaryngologists, and twenty-seven specialists in internal and other diseases.

## THE ROYAL PHOTOGRAPHIC SOCIETY'S EXHIBITION

THE Royal Photographic Society's Annual Exhibition at the Society's House, London, closes on October 9. According to a report in *Nature* the exhibits in the scientific and technical section that seem to be the most novel or the least often seen are some results obtained by a combination of the cinematograph and microscope, and a photograph of the ultra-violet spectrum of silicon by Professor A. Fowler, of the Imperial College. This is done in sections, from wave-length 2820–2420 Å.U. on ordinary plates, from 2250–1840 Å.U. on plates smeared with a fluorescent oil, and from 2150–1250 Å.U. on Schumann plates using a vacuum grating spectrograph.

Cinematography is more fully represented than it has been before. Dr. S. Bayne-Jones shows the life-history of the Penicillium, taking the pictures at the rate of two per minute by means of an automatic mechanism which also turns on the light. Dr. S. E. Sheppard and Dr. R. H. Lambert, of the Kodak Research Laboratory, have photographed the electrophoresis of rubber latex particles, the film showing the Brownian movement of the particles and their movements in an electric field. Mr. Loyd A. Jones, also of the Kodak Research Laboratory, has studied the growth of crystals using elliptically polarized light and the "Kodachrome" process, and he contributes films of six different substances in very realistic colors. There are several other films of the more usual type and also a collection of historic films, including the famous train film of Lumière Bros., which was the first ever exhibited to a paying audience (in 1895). Photo-micrography is associated with color processes in the four autochromes of Dr. C. F. Elam, of the Royal School of Mines, which show at a magnification of ×100 various crystalline forms of silver nitrate taken between crossed Nicols. Dr. L. F. E. Johnson, besides two slides taken in a similar way, has two illustrations of fabrics as they appear under the microscope when illuminated by Rheinberg's differential color stop, which shows the warp red and the weft blue.

Of the numerous photo-micrographs taken in the usual manner we would direct attention to Dr. G. H. Rodman's series of 24 which illustrate the various forms of hairs occurring on plants which are recognized as liable to produce mischief (sting, etc.) in those who come in contact with them; Mr. J. H. Pledges' 9 photographs (×10) of an Indian mistletoe that has no leaves; cultural types of meningococci and gonococci from the Lister Institute of Preventive Medicine; and a series of the rabbit embryo in utero and rabbit placenta, each showing various stages in its development, by Mr. G. S. Sansom. There are many others of considerable merit and interest, and a large collection that shows the present results of metallography obtained in numerous laboratories where it is practiced, including the National Physical Laboratory. Viewing the photomicrographs as a whole, the difficulty of getting good results at certain rather low magnifications seems to have been entirely overcome, and they indicate that no more detail is obtained by increasing the magnification above about ×2000.

Radiography and photographic printing in colors are as well represented as ever. The structure of emulsions, and the changes produced in the silver bromide grains, are shown by Mr. L. F. Davidson and the British Photographic Research Association, and Mr. L. E. Jewell shows the advantage of what he calls "relief illumination" in photo-micrography, that is, the mirror in the vertical illuminator is considerably decentered so that there is a mixture, in regulatable proportions, of oblique specular and diffused light. The General Motors Corporation of Michigan, U. S. A., contributes prints of its Midgley Optical Gas Engine Indicator, which records as curves the character of the combustion in automotive engines. Of the various trades exhibits, those that impressed us most were Messrs. Ross's rapid speed photographs of the last test match taken with a 40-inch *f*/8 Teleros lens from outside the ground, and Messrs. Ilford's illustrations of the method of making and testing their light filters.

## THE CONFERENCE ON BITUMINOUS COAL

THE Conference on Bituminous Coal to be held at the Carnegie Institute of Technology in Pittsburgh has been definitely scheduled for November 15 to November 19.

The purpose of the meeting, according to Dr. Thomas S. Baker, president of the Carnegie Institute of Technology, is to bring together the men of all countries who have done notable work in the study of more scientific and rational utilization of soft coal. Listed for discussion are such questions as the manufacture of substitutes for gasoline from coal; the complete gasification of coal; high temperature and low temperature carbonization; by-products; smokeless fuel; pulverized coal; hydro-electric power versus steam power, etc.

As a result of a visit to Europe this past summer by Dr. Baker, several distinguished scientists and fuel technologists in Europe have accepted his invitations to attend the congress. German representatives will include privy councilor Professor Franz Fischer, director of the Institute for Coal Research at Mulheim-Ruhr, and Dr. Friedrich Bergius, of Heidelberg. England will be represented by Dr. C. H. Lander, director of fuel research of the Department of Scientific and Industrial Research; Dr. R. Lessing, prominent fuel technologist, and Geoffrey Gill, engineer and specialist in the manufacture of gas. From France will come General Georges Patart, who was in charge of the manufacture of explosives during the war and who is the inventor of a process for making methyl alcohol from coal. In addition, there will be a representative from the Office National des Combustibles Liquides. Besides these, a number of European specialists who have done work in the development of certain processes are expected to attend.

American engineers, scientific men and fuel technologists who have been doing important research work in the chemistry of coal and other problems will have a large share in the program.

Among the members of the advisory board assisting in the development of the conference plans are Andrew W. Mellon, secretary of the United States Treasury; John Hays Hammond, engineer and inventor; Otto H. Kahn, banker; Charles M. Schwab, steel manufacturer; Samuel Insull, public utility leader; E. M. Herr, president of the Westinghouse Electric and Manufacturing Company, and Dr. Frank B. Jewett, vice-president of the American Telephone and Telegraph Company and director of research of the Bell Telephone Research Laboratories.

## THE MOHONK CANCER SYMPOSIUM

AT a dinner to the foreign guests held in New York at the end of the symposium held at Mohonk from September 20 to 24, and attended by about 250 physicians, Sir John Bland-Sutton declared that the meeting would make medical history. He spoke in part as follows:

> We have had a very strenuous week, and I will say in all my experiences in congresses and association meetings I have never been to one in which there was a more complete absence of acrimony and so much work was accomplished. The zeal which led so many investigators, surgeons and physicians to cross the Atlantic and come from all parts of the American continent is creditable, and the earnestness they displayed in the conference is beyond all praise. In fact, they were so earnest in their discussions that they even continued them on the hotel porches and in the dining room. This meeting is certain to make medical history.

Dr. Wendell Phillips, president of the American Medical Association, said:

> This meeting has done much to stabilize the knowledge that we have of cancer, and it will clarify the opinions, not only of medical men, but of the public. In this respect it will accomplish what no other meeting has done before. It is a great thing to preach up the right rather than to preach down the wrong, and those who have been at Mohonk have been preaching up the right.

Dr. Welch said:

> The great note struck at the Mohonk symposium was the tremendous importance of the cancer question and the appalling problems which it presents. There was never a time when the disease presented problems of such magnitude. The general public and the medical profession must be aroused to the vital importance of efforts to control cancer. However inadequate our knowledge is to-day, it is an obligation of the profession to the general community that every effort be made to control this scourge. The community must be taught that all types of cancer are not certainly and inevitably fatal if they are recognized and properly treated at an early stage. Emphasis was placed upon the importance of research work, the need of further additions to our knowledge on the one hand, and equally, upon the necessity of applying our existing information for the saving of human lives and suffering. There is no disease to which larger additions have been made to our knowledge than cancer, but because this knowledge does not reach the public which we are most anxious to reach, this seems trivial. The many papers and discussions will be published and make a volume which will be an epochal contribution to our knowledge of cancer.

Among the European specialists present were: Dr. Raffaele Bastianelli, professor of surgery at the University of Rome; Dr. Leon Berard, professor of surgery at the University of Lyons; Sir John Bland-Sutton, Bt., president of the Royal College of Surgeons, vice-chairman of the British Empire Cancer

Campaign; Dr. Ferdinand Blumenthal, professor of internal medicine at the University of Berlin; Dr. William deVries, president of the Netherlands Cancer Institute, Amsterdam, professor of pathologic anatomy at the University of Amsterdam; Dr. Henri Hartmann, professor of surgery at the University of Paris; Dr. J. Maisin, professor at the University of Louvain; Dr. James A. Murray, director of the Imperial Cancer Research Fund, London; Dr. Claude Regaud, director of the Pasteur Laboratory of the Radium Institute, Paris; Dr. Albert Reverdin, general secretary to the Anti-Cancer Center of Geneva.

Among the Americans were: Dr. Howard Canning Taylor, professor of clinical gynecology at Columbia, president; Dr. Francis Carter Wood, director of the Institute for Cancer Research, Columbia, vice-president, and Dr. George A. Soper, managing director of the American Society for the Control of Cancer; Dr. Robert B. Greenough, member of the Harvard Cancer Commission and director of the Huntington Memorial Hospital, Boston; Dr. James Ewing, professor of pathology, Cornell Medical College, and director of the Memorial Hospital, New York; Dr. Charles Mayo, Rochester, Minnesota; Dr. Joseph Colt Bloodgood, associate professor of clinical surgery at the Johns Hopkins University; Dr. William H. Welch, director of the Institute of Hygiene and Public Health, the Johns Hopkins University; Dr. Burton J. Lee, Dr. George H. Semken, Dr. Willy Meyer, Dr. Isaac Levin, Dr. John Shelton Horsley, of Richmond; Dr. Alson R. Kilgore, of San Francisco; Dr. Alexander Primrose, of Canada; Miss Maud Slye, of Chicago, and Dr. Erwin Smith, of Washington.

## THE TENTH INTERNATIONAL CONGRESS OF ZOOLOGY

### PRELIMINARY ANNOUNCEMENT

THE Ninth International Congress of Zoology in session at Monaco in March, 1913, decided to hold the tenth meeting in 1916 at Budapest, Hungary, under the presidency of the undersigned. Unfortunately the events of the war made it impossible to adhere to this decision, and the meeting of the Tenth Congress had to be postponed. The present international situation is now such, however, that this congress can be held during the coming year.

In accord with the Permanent Committee of the International Congress of Zoology I have the honor, therefore, to announce that the Tenth International Congress of Zoology will meet in Budapest, Hungary, on September 4 to 9, 1927, and that all zoologists and friends of zoology are hereby cordially invited to attend.

The detailed program of the Congress will be issued before the end of the present year and sent to those interested.

DR. G. HORVÁTH,
*President of the Tenth International Congress of Zoology, Director of the Department of Zoology, Hungarian National Museum*
BUDAPEST, HUNGARIAN NATIONAL MUSEUM,
SEPTEMBER 4, 1926

## SCIENTIFIC NOTES AND NEWS

PROFESSOR H. A. LORENTZ, of the University of Leyden, will arrive in Ithaca early in October as visiting lecturer on the Schiff Foundation. He will deliver a series of about thirty lectures on mathematical physics.

THE friends of Dr. William H. Park, of New York City, desiring to present a testimonial of their regard and recognition of his service to humanity, have planned to have his portrait painted and placed in the New York Academy of Medicine.

GEORGE MURNANE, vice-president of the New York Trust Company, has been elected president of the American Association for Medical Progress. Mr. Murnane succeeds the first president, Dr. Thomas Barbour, director of the Museum of Comparative Zoology at Harvard University.

DR. WALTER A. BAETJER, of Baltimore, was elected president of the American Climatological and Clinical Association at the recent meeting in Philadelphia.

CHARLES M. SCHWAB has been elected president of the American Society of Mechanical Engineers. He will formally assume the office at the annual meeting of the society in New York early in December, at which time he will succeed William L. Abbott, of Chicago.

AT a recent meeting of the board of trustees of the Mt. Desert Island Biological Laboratory Dr. H. V. Neal was elected to succeed Professor Ulric Dahlgren, who resigned as director. Mr. William Proctor was elected to serve as president during the absence of Dr. Harold L. Senior, who will be abroad next year.

THE trustees of the recently incorporated Bermuda Biological Station for Research are as follows: E. J. Allen, director, Marine Biological Association, Plymouth, England; J. H. Ashworth, University of Edinburgh; E. G. Conklin, *chairman*, Princeton University; E. V. Cowdry, the Rockefeller Institute for Medical Research; C. B. Davenport, of the Carnegie Institution; B. M. Duggar, Washington University, St. Louis; R. A. Harper, Columbia University; Ross G. Harrison, Yale University; A. G. Huntsman,

director of the Atlantic Biological Station, St. Andrews, N. B., Canada; E. L. Mark, Harvard University; E. A. McCallan, director of agriculture, Bermuda, and H. W. Rand, *secretary-treasurer,* Harvard University.

THE New York State Commission on Ventilation has recently opened an office at 370 Seventh Avenue, New York. The original members of the commission, Professor C.-E. A. Winslow (chairman), D. D. Kimball, Professor Frederic S. Lee, Dr. James Alexander Miller, Professor Earle B. Phelps and Professor Edward L. Thorndike, continue to serve, and Mr. Thomas J. Duffield has become associated with the commission in the capacity of executive secretary. The commission, which has been quiescent since the publication of the exhaustive report of its findings in 1923, now intends to assume again an active rôle, and to become a clearing house for the dissemination of accepted theories in the science of ventilation. Its work, as in the previous years of its existence, is being financed by the Milbank Memorial Fund of New York.

DR. FRIEDRICH KUSTNER, director of the observatory of the University of Bonn, has celebrated his seventieth birthday.

THE *Journal* of the American Medical Association reports that Dr. Isidro Ayora, professor of obstetrics in the faculty of medicine at the Central University of Ecuador, has been appointed provisional president of the Republic of Ecuador. He has served in the cabinet and as president of the city council of Quito, and has inaugurated a number of useful reforms. Two other physicians have been given cabinet positions, Dr. P. P. Eguez, minister of social work, and Dr. L. Palacios, minister of war.

AS a result of the resignation of Rector Achille Sclavo, professor of hygiene at the University of Sienna, the office of rector for the next two years has been bestowed on Professor Bolacci, of the department of botany.

DR. WALTER S. FROST, who for the past seven years has been assistant professor of chemistry at the University of New Hampshire, has joined the staff of Skinner, Sherman and Esselen, Inc.

DR. FRANK M. CHAPMAN and Dr. Robert Cushman Murphy, who were official representatives of the American Museum of Natural History at the International Ornithological Congress held at Copenhagen, May 24–29, have returned. While abroad Dr. Chapman delivered an address in London before the Royal Geographical Society on Darwin's Chile.

ACCORDING to a cable received at the Smithsonian Institution, Dr. Mann, director of the Smithsonian-Chrysler Expedition, has left Colombo, Ceylon, for the 12,000 mile journey to New York. On board his ship are 200 cages of wild animals captured by the expedition in East Africa, including a giraffe, three leopards and many other animals, birds and reptiles. The expedition will probably arrive in New York towards the end of October.

DR. OSCAR RIDDLE sailed from New York on September 29, as the delegate of the Carnegie Institution and of the Washington Academy of Sciences, to the First International Congress for Sex Research. The congress is to be held in Berlin, from October 10 to 16.

DR. W. F. PROUTY, professor of economic geology in the University of North Carolina, spent the latter part of the summer in the Southern Appalachian region looking up new sources of ornamental building stone.

WALTER GRANGER, associate curator in paleontology, and Mr. N. C. Nelson, associate curator of archeology, have been appointed official representatives of the American Museum of Natural History to the Third Pan-Pacific Science Congress to be held in Tokyo, Japan, October 27 to November 9, 1926.

THE following foreign scientific men who spent last year at the New Jersey Agricultural Experiment Station have returned to their laboratories: Mr. H. Sandon, of the department of general microbiology of the Rothamsted Experiment Station, England; Mr. A. Nömmik, professor of agronomy at the University of Tartu, Esthonia, and Mr. S. T. Jensen, associate chemist of the Statens Planteavls Laboratorium, Lyngby, Denmark.

DR. JAKOB BLOM, of the department of physiology at the University of Copenhagen, and Dr. Hans Jenny, of the Laboratory of Agricultural Chemistry, Zürich, Switzerland, both fellows of the International Education Board, have arrived in this country to pursue studies at the New Jersey Agricultural Experiment Station.

AMONG recent visitors to the National Herbarium at Washington have been Dr. A. B. Rendle, keeper of the herbarium of the British Museum of Natural History, and Professor Albert N. Steward, of the University of Nanking, China. Professor Steward has sent collections of grasses from central China to the National Herbarium.

DR. GEORGE H. GODFREY, who was for eight years in plant pathological work in the Bureau of Plant Industry, Washington, D. C., and for the past two years plant pathologist with the Bayer Company, Inc., New York City, has accepted the position of

nematologist with the Association of Hawaiian Pineapple Canners, with headquarters at the University of Hawaii, Honolulu, Hawaii. Mrs. Lois Stewart Godfrey, for the past three years assistant professor of household science at the University of Toronto, is now in Honolulu. She is carrying on her studies with ultra violet light in association with Dr. Nils P. Larsen, at Queen's Hospital, Honolulu.

PROFESSOR A. RADCLIFFE BROWN recently visited the United States, *en route* to Sydney, Australia, where he has been appointed to the new chair of anthropology in the University of Sydney. While here he made a tour of institutions interested in anthropology.

PROFESSOR THEODORE VON KARMAN, of the Aerodynamical Laboratories at Aachen, will visit the United States during the autumn under the auspices of the Daniel Guggenheim Fund for the Promotion of Research in Aeronautics. He will visit the laboratories concerned with aerodynamics and deliver a series of lectures on modern phases of advanced theoretical aerodynamics either in New York or in Washington.

DR. OSKAR GANS, professor of dermatology at the University of Heidelberg, is to give a course of lectures this winter on "The Histology of Skin Diseases" at the Mayo Clinic, Rochester.

CAPTAIN JOHN NOEL, official photographer with the Mt. Everest expedition of 1924, gave a lecture at the American Museum of Natural History on October 7 entitled "The Epic of Everest."

COLONEL W. G. GREELEY, chief of the United States Forestry Service, and Charles Lathrop Pack, president of the American Forestry Association, gave addresses during the conservation week program at the Sesqui-Centennial Exposition at Philadelphia on the necessity of forest conservation.

DR. MAX MASON, president of the University of Chicago, will make the principal address at the annual dinner on October 13 of the Chicago Medical Society.

A NATION-WIDE movement to establish a million dollar foundation to carry on the work of Luther Burbank has been started. Stanford University had planned to carry on the work of plant development at the scientist's request in so far as the university would be able with available funds. The Chamber of Commerce of Sebastopol, California, where Mr. Burbank had his plant farm and laboratory, has made the suggestion that the entire country be invited to participate in the establishment of the foundation, and Dr. Ray Lyman Wilbur, president of Stanford, has approved the suggestion.

THE manuscript journal in which the Reverend L. L. Langstroth recorded his observations on the behavior of honey bees and his experiments in the invention of the modern bee-hive has been discovered in an attic in Dayton, Ohio. At a recent meeting held by the Ohio Beekeepers' Association as a memorial to the founder of modern beekeeping, this journal was exhibited and was then presented to Cornell University as part of the special library of beekeeping literature which is established there.

BACTERIOLOGISTS from all parts of Russia and several from France discussed disease control at a Pan-Russian Bacteriology Congress at Odessa. The meeting was held on the tenth anniversary of the death of Dr. Elie Metchnikoff. Mme. Metchnikoff was present at the meeting and is at present engaged in collecting documents relating to her husband's researches that will be included in a museum to be dedicated to his memory at Moscow.

A MEMORIAL tablet has recently been placed on the house in the Luisenstrasse, Berlin, formerly occupied by the Imperial Health Bureau, where Koch discovered the tubercle bacillus.

DR. CLARENCE ABIATHAR WALDO, professor emeritus of mathematics at Washington University, St. Louis, died on October 1, aged seventy-four years.

DR. NORMAN FITZHUGH EBERMAN, associate professor of chemistry at Johns Hopkins University, died from self-administered poison. Dr. Eberman was twenty-seven years old.

DR. J. L. WORTMAN, of Brownsville, Texas, formerly assistant curator of paleontology at the American Museum of Natural History, died recently.

THE deaths are announced of Dr. Rudolf Böhm, formerly professor of pharmacology at the University of Leipzig, aged eighty-three years, and Professor Edmund Krompecher, head of the department of pathological anatomy at the University of Budapest.

THE sixth French Congress of Industrial Chemistry was held at Brussels from September 26 to 30, under the presidency of Dr. Gilbert.

THE first Pan-American Conference of National Directors of Public Health opened in Washington on September 27 in the Pan-American Union with a distinguished gathering of delegates from South and Central America and health experts of the United States. The program extended over three days.

THE proposed million dollar fund of the American Society for the Control of Cancer has been increased by $90,000 from recent contributions. This brings the total subscriptions to $426,647.

A FINE collection of mounted big game fish gathered by Zane Grey, the novelist, has been presented to the American Museum of Natural History. The fish number about 200 and are valued at about $100,000. The collection is now at Mr. Grey's home at Lackawaxen, Pa. Van Campen Heilner, field representative of the museum, will go there to superintend their preparation for shipment. They will be placed in the new wing of the museum and will probably be ready for public exhibition early next year.

THE French scientific Polar expedition under Lieutenant Darcis is expected to leave Le Havre shortly on board the Norwegian ship *Munin*. The expedition, composed of 15 persons, will take with it two light aeroplanes, six motor sledges, six trailers and 24 tons of provisions. The members of the party, besides Lieutenant Darcis, consist of six mechanics, two airmen, four scientific observers, one film operator and one wireless expert. The expedition intends to winter in the extreme north of Spitzbergen and to start in February on a journey which is expected to last three months straight across the North Pole to Point Barrow, in Alaska. The motor sledges of 50 h.p. are designed to travel over ice, snow or land, and have also floats to prevent their sinking in case they fall into the water.

UNDER the auspices of the Argentine Geographical Institute and backed financially by the Argentine government, an expedition is being organized to explore the antarctic and south pole regions. Antonio Pauly, prominent engineer, will head the party. The expedition will start November 15, going first to Ushuaia, territory of Argentina. From there the party will proceed aboard a whaler to Graham Land, where a base will be established. From Graham Land flights will be made in airplane over the western coast of Graham Land and the Weddell Sea. When the weather permits a flight to the south pole will be attempted so as to explore 1,750 miles of unknown territory. Later the expedition will go by planes to Ross Sea, where they will board a ship and proceed to the Australian coast. From Australia the party will return to Buenos Aires.

## UNIVERSITY AND EDUCATIONAL NOTES

THE department of chemistry at the West Virginia University recently moved into its new million dollar chemistry building, which is said to be a model in this type of architecture. For lack of funds certain portions of it have been left uncompleted for the present.

THE department of geology of the University of North Carolina plans to move into its new geological building about the first of January. The new building is of fireproof construction, has four stories and a basement and will house geology, mineralogy and geography beside a large departmental library and a museum. Special features of the building are a precision research laboratory and a seismograph.

DR. JOSEPH S. AMES, professor of physics and dean of the college of arts and sciences at the Johns Hopkins University, has been appointed provost of the university to take the place of Dr. Charles K. Edmunds, who has resigned in order to become American director of Lingnan University, China.

DR. S. C. BROOKS, biologist of the Hygienic Laboratory, U. S. Public Health Service, Washington, D. C., has resigned to become professor of physiology and biochemistry and head of the department at Rutgers University.

DR. NATHAN L. DRAKE, formerly with the Procter and Gamble Company, Ohio, has been appointed professor of industrial chemistry at the University of Maryland.

DR. D. R. HARPER, of the general engineering laboratory of the General Electric Company, has been appointed associate professor on the physics staff at Union College. Dr. Harper will, at the same time, continue with the general engineering laboratory in a consulting capacity.

DR. R. L. STARKEY, of the department of bacteriology of the University of Minnesota, has been appointed assistant professor in soil microbiology at Rutgers University and associate microbiologist at the New Jersey Agricultural Experiment Station.

DR. WILLIS DERYKE, formerly instructor at the University of Iowa and editor of the "Proceedings" of the Iowa Academy of Science, begins his work this fall at Illinois College, Jacksonville, as acting professor of biology.

DR. S. VAN VALKENBERG, until recently in charge of the map-making section of the Dutch government at Batavia, Java, has been appointed lecturer in the school of geography at Clark University for the second semester of 1926–27. He will offer two courses on the geography of the Far East and the geography of Europe. Dr. Bruno Dietrich, professor of geography at the University of Breslau, will be a special lecturer at the university early in 1927. He will discuss particularly the geography of central Europe.

DR. JOHANNES BERGER, professor of mineralogy and petrography at the University of Tübingen, has been called to the chair of mineralogy and geology at the Hanover Institute of Technology to take the place of Professor Otto Erdmannsdörffer.

## DISCUSSION

### THE TEACHING OF EVOLUTION IN ARKANSAS

THERE can be no doubt but that a great effort will be made to induce the Forty-Sixth General Assembly of the State of Arkansas to enact a law to prohibit the teaching of evolution in tax-supported schools and colleges of Arkansas.

I am giving below a correct copy of a petition which will be presented to the Legislature when it meets in regular session January 1, 1927.

"To the Forty-Sixth General Assembly of the state of Arkansas: We, the undersigned citizens, voters and taxpayers of the State of Arkansas and County of Randolph, believing in the Mosaic account of Creation, and believing the Darwinian theory of the origin of man to be erroneous, false, and misleading, and calculated in its nature to lead men from the truth of God and to instill in the spirit of infidelity;

"Do, therefore, petition your honorable body to enact a law, similar to the 'Tennessee Anti-Evolution Law' with just such changes and modifications as will make it applicable to the state of Arkansas.

*Explanation*

"We believe in Evolution just as far as it goes; we believe in Evolution in the mineral, vegetable, and animal kingdoms.

"We believe Evolution has produced changes in the earth. Its influence is recognized in the development of machinery and in the formation of languages and of governments. It produces many varieties of beautiful and useful things as flowers, apples, etc., of hogs, sheep, cattle, etc. It has no doubt produced varieties of men and of monkeys, but we do not believe that any process of Evolution whatever can produce an apple tree from a mustard seed, a milk cow from a bull frog, or a man from a monkey. Such a belief not only disputes reason and science, but it disputes the decrees of the Most High as recorded by His servant, Moses, in Genesis 1: 11, 1: 24, 1: 26.

"We ask the *Star Herald* and its exchanges to give this petition publicity. To afford ample notice, we ask all publishers in the state to publish this, however it may come to their notice. We hope that the citizens of every county of the state will petition their representatives to support this measure."

Respectfully,
J. Will Henley, Minister Christian Church.
W. E. Hall, Pastor M. E. Church, South.
O. A. Greenleaf, Baptist Pastor.
Jos. Froitzheim, Pastor St. Paul's Catholic Church.
G. W. Million, County and Probate Judge.
Rufus A. Mock, County School Superintendent.
J. W. Brown, M.D.
Geo. M. Booth, Prosecuting Attorney-Elect.
W. L. Pope, Ex-Circuit Judge.
Wm. H. Johnson.

—Pocahontas *Star Herald*

It is indeed unfortunate that a petition like the one above is to be presented to the Arkansas State Legislature at this time as in the next general election an amendment to the constitution will be voted on, which will permit school districts to increase the local school tax from 12 to 18 mills to relieve the high schools of the state, Arkansas' new governor is pledged to support proposed measures which have as their object the relief of the public schools and the colleges and the university, and demands for the passage of anti-evolution laws will retard the progress of Arkansas schools just at a time when people are awakening to the real needs for better educational institutions.

C. BUSH

ALICIA, ARKANSAS

### THE CONCILIUM BIBLIOGRAPHICUM

A PREVIOUS note[1] called attention to the fact that the bibliography of the Concilium Bibliographicum is incomplete so far as the Oligochaeta are concerned. Other groups are similarly incomplete. The director[2] has explained that the number of cards required by the present rate of publication of biological papers is so large that the cost of subscription will be greater than the appropriations for bibliographic purposes of the subscribing European institutions. As the Concilium apparently can print only as many cards as the majority of its subscribers can afford, a selection must be made, the bases for which Dr. Strohl has explained in the note just mentioned. It is evident of course that the value of any bibliography varies according to its completeness, and while the Concilium is at present making a valuable contribution to the advancement of zoological investigation, its aid to zoologists is not as great as is possible. Those who are especially dependent upon this service for bibliographic information are correspondingly handicapped by its deficiencies. It would be greatly to the advantage of such workers if some scheme could be devised to enable the Concilium to publish its accumulated manuscripts, to make its service complete and to expedite the issue of its cards so as to form a more nearly contemporary announcement of the publication of papers. Such an improved service would undoubtedly attract a greater number of individual subscribers to various groups or subjects. The scheme might take the form of a loan to enable the publication of cards that can not be financed from subscriptions. As the financial situation improves, the accumulated cards will doubtless be taken up by the subscribing institutions. In the meanwhile those institutions and individuals who can afford it will have had the benefit of the more complete bibliography.

[1] SCIENCE, July 3, 1925.
[2] Strohl, SCIENCE, Feb. 25, 1926.

In spite of this incompleteness of the bibliography the Concilium service is exceedingly valuable and the writer has been surprised to discover that many zoologists, especially among the younger investigators, are ignorant of the Concilium Bibliographicum and the assistance which its services can render. It is not necessary in this connection to call attention to the difficulties caused by disregard of previous or contemporary work, or by wrong, inadequate and incomplete references. Practically every investigator has had experience with such difficulties. Nor is it necessary to give any explanation as to the value of the card index system. Its handy size, flexibility, rapidity of adjustment and ease of use are well known to-day. It is not so well known, however, that one can procure at short notice the printed cards of the index size from the Concilium Bibliographicum at Zürich, bearing the usual bibliographic information and in addition brief notes as to new categories in systematic works, or as to data or discussions contained in the paper which may not be suggested by the title. It makes no difference whether one wishes a bibliography of the literature on metamorphosis, the insects of Palestine, the fauna of Japan or the coelenterates of the world or any one of numerous other subjects that might be suggested.

This service is valuable to many sorts of workers and in many ways but appears to the writer to be most valuable to those who are working with inadequate literary facilities. A young zoologist, for instance, in an Asiatic country or in a small college here finds himself confronted by a new and important problem which promises to be of considerable interest. Libraries may be lacking, very distant, or if available hopelessly inadequate, funds are notoriously difficult to obtain, and the need of literature is often not appreciated by those who control the budgeting of appropriations. Back numbers of journals are difficult to secure, expensive, and when obtained may contain only a small amount of material which will be immediately useful for the problem in hand. With the cards of the Concilium and the notes they furnish as to subject-matter, number of pages, illustrations, etc., it is possible to determine to some extent at least the relative importance of the papers and plan the expenditure of limited funds more wisely than would otherwise be possible. Reprints, odd number of journals, monographs, can then be secured from dealers or authors, and arrangements made for loans from libraries at a distance.

Furthermore, one can subscribe for the cards of any group in which one is especially interested. This service is again particularly valuable to those working under the handicap of inadequate literary equipment, as the cards constitute announcement of publication of papers that might not otherwise be encountered. Even those who have occasional or frequent access to large libraries find their task simplified by this aspect of the service.

G. E. GATES

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## THE DISCOVERY OF VITAMINES

LAFAYETTE B. MENDEL, in his "Nutrition, the Chemistry of Life" (p. 59), has, by a quotation from Pereira's "Treatise on Food and Diet" (New York, 1843), reminded us of the fact that, long before Lunin, the existence was surmised of those substances in food which, at Funk's proposal, have been combined under the name of vitamines.

Without in the least derogating from Hopkins' great deserts in this matter, but only for the sake of completeness, I venture to state that in 1905, a year before Hopkins published his interesting communication in the *Analyst*, the late C. A. Pekelharing, professor of physiological chemistry and histology at the University of Utrecht, delivered an address at the annual meeting of the Netherlands Medical Society[1] which, appearing only in Dutch, did not, we regret to say, become known abroad, and in which the following passage occurs:

> When white mice are fed on bread baked with casein, albumin, rice-flour, lard and a mixture of all the salts which ought to be found in their food, while they are only given water to drink, the animals starve to death. During the first few days all is well. The bread is eagerly nibbled and the mice look healthy. But soon they get thinner, their appetite diminishes and in four weeks all the animals are dead. If, however, instead of water they are given milk to drink, they keep in good health, though the quantity of albumen, lactose and fat which they assimilate with the milk is quite negligible in comparison with what the bread on which they are fed contains. The element in the milk which keeps the animals alive also occurs in the whey from which casein and fat have been eliminated. Till now my efforts constantly repeated during the last few years, to separate this substance from the whey and get to know more about it, have not led to a satisfactory result, so I shall not say any more about them. My intention is only to point out that there is a still unknown substance in milk, which, even in very small quantities, is of paramount importance to nourishment. If this substance is absent, the organism loses the power properly to assimilate the well-known principal parts of food, the appetite is lost and with apparent abundance the animals die of want. Undoubtedly this substance not only occurs in milk but in all sorts of foodstuffs, both of vegetable and animal origin.

[1] *Nederlandsch Tijdschrift voor Geneeskunde*, 1905, II, p. 111.

On an objective consideration of the development of our knowledge concerning the existence of vitamines we must, in my opinion, come to the conclusion that it is impossible to speak here of a discovery made by one person and of no use to quarrel about who was the discoverer, but that we can only think here of a conviction, growing in the course of years, that there are indispensable, though still unknown elements in food—a conviction which has led to a more and more searching investigation.

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## A LOGIC POEM

What is logic? Are not the following examples cases of logic? The first is a poem developed out of a well-known Irish distich. (1) It goes thus:

Unless the kettle boiling be
They labor in vain who make the tea;
Unless the tea be properly made
My guest will not like it, I am afraid;
Unless my guest contented be
She'll never again come visiting me.

*Consequently:*

Unless the kettle boiling be
She'll never again come visiting me.

(2) Are the two following sentences logically equivalent or are they not? "Not unless it rains do I take an umbrella," "Not unless I do not take an umbrella does it not rain."

(3) A child of four, sitting at the dinner table, was making the interesting experiment of eating her soup with a fork. Her mother said to her: "Nobody eats soup with a fork, Emily," and Emily replied, "*But* I do, and I am somebody."

This last is an antilogism—a form of reasoning which it has been proposed to substitute for the syllogism. It is the argument of rebuttal, the conversational argument, and it doubtless arose earlier, in the development of the human race, than the argument of drawing conclusions. It is certainly fully as easy, as is proved (if proof were necessary) by its having been used, in exactly this form, by a very young child. Here is another example of it, expressed in terms of the logician's favorite $s$, $m$ and $p$:

"If no priests are martyrs and there are no saints who are non-martyrs, then it-is-impossible-that any saints should be priests." Here it will be noticed that the common term of the first two premises is martyrs and non-martyrs, *i.e.*, a positive and a negative term. Common logic, however, insists upon it that the term common to two premises must be absolutely and exactly the same; nevertheless, this argument would appear, to the untrained logician, to have a certain degree of validity; what is the trouble? Senator N. said: "*It-cannot-be-that* any of these measures are idiotic, *for* they are all necessary, and nothing that is necessary is idiotic." This is not common logic. What, then, is it? What *is* logic?

Christine Ladd-Franklin
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# QUOTATIONS

## A BERTHELOT MEMORIAL

It is not as a man of a particular nationality that a monument to Berthelot, one of the pioneers of synthetic chemistry, is proposed. France has reason to be proud that she gave birthplace and domicile to this great chemist, "the undisputed head of French chemistry and perhaps the most versatile of modern chemists" (as one of our foremost chemists wrote a few years ago), as well as to Pasteur, the pioneer in another field of science; Mme. Curie in still another, Henri Poincaré, "the greatest mathematician of his age," and Henri Bergson, who has illustrated in his own achievement the claim he has made for France in the field of philosophy that she has been "the great initiator"—not to go back into certain other periods when the scepter of science was undisputedly held in her hands.

It is characteristic of the French that they hold their supreme men of science and the arts and letters in highest popular esteem. There is scarcely a town in France that does not have a street or a square bearing the name of Pasteur, while no great scientist, man of letters, artist, musician, is without his monument. When Goethe was in Paris a century ago (1827) he wrote of the sympathetic atmosphere of the place:

> Only imagine a city like Paris where the cleverest heads of a great kingdom are grouped together in one spot and in daily intercourse incite and stimulate each other by mutual emulation, where all that is of most value in the kingdom of nature and art from every part of the world is daily open to inspection, and all this in a city where every bridge and square is associated with some great event of the past and where every street corner has a page of history to unfold.

The thing celebrated is not always nor even usually military achievement but intellectual power. Goethe said that such intellectual power could never be met with a second time on any single spot in the whole world. It was entirely in character that the people of Paris, when the days were almost if not quite the blackest in the war, when the city was within reach of the guns of the enemy and when there were night

combats in the skies, should have gathered in the great amphitheater of the Sorbonne, thousands of them, in the presence of the President of France and the Minister of War, not to speak of the war or to stir new zeal, but to pay homage to a great scientist and teacher, M. Berthelot. To him it is now proposed to erect an international memorial. He was foremost in giving effect to the conception that chemistry can become creative in the organic field as well as in the inorganic, and so passed from the purely analytic to the synthetic.

While Berthelot does not stand alone as did Pasteur, he was of the small group in the van, and his brilliant service to his science deserves to be remembered not by France alone but throughout the world that has been benefited by his researches. It is suggestive of his service that his influence has been extended through the researches of his pupils, among whom was M. Sabatier, a recipient of the Nobel prize, whose discoveries in pure science have found such important practical application that an American manufacturer has asked the privilege of making, through the American Chemical Society, a material recognition of one of them. It is significant, too, that the proposed memorial building which is to be a center of continued research in organic chemistry is to stand by the side of Napoleon's tomb. So are peace's renowned victories to be celebrated no less than those of war.—*The London Times.*

## SCIENTIFIC BOOKS

*The Physiology of Plants: The Principles of Food Production.* By GEORGE JAMES PEIRCE. x + 363 pp. New York, Henry Holt and Co. 1926.

PROFESSOR PEIRCE'S new book will be welcomed by both teachers and students. It represents many improvements on the author's earlier treatise. I like its literary style and the general background of broad and liberal philosophy that shows through on every page. It presents in a very readable form an account of the subject as it appears to the author, after his many years of successful teaching and research. It is characteristically a personal account rather than an attempt to present the science in an impersonal way. "Some of the departures from the usual are by way of suggestion for the future of the science, some for the convenience of the reader," is the second sentence of the preface. A few lines below, we read, "Whatever my own opinions about disputed matters may be, I have wished to express them, not as dogma, but as hypothesis or opinion, hoping and desiring always to say what will stimulate rather than satisfy." It is indeed a book of personal notes and suggestions, which will surely be stimulating and pleasant to read, though just as surely not wholly satisfying to either teacher or student.

Some of the very features that make this volume pleasantly readable and stimulating, or even exciting in places, due to the geniality and broad facility and originality of the author, may tend to detract from the usableness of the presentation for elementary classes, but the book is intended for more advanced students. It seems desirable that beginners should first study a clearly impersonal presentation of the current, or at present orthodox, theories and modes of expression before being led far into the confessedly mischancy although stimulating realm of theoretical and philosophical criticism. The present volume includes many critical discussions of pieces of research that are not adequately described, but references to the literature are generally given, and it is intended that the reader will be familiar with the papers referred to before trying to understand the criticisms.

Fundamental physical and chemical phenomena are in many instances too briefly treated, perhaps because the reader is supposed to be already familiar with them. For one example, air is said (page 25) *to dissolve water vapor,* and the subsequent presentation of relative humidity is incomplete, with no mention of vapor-tension deficit and the allied important relations. The student who leans upon the solvent theory in studying the vaporization of water into a supernatant gas will surely find himself in intellectual quicksands if he tries to travel far.

Professor Peirce's treatment of the ascent of water in plants is extensive and should arouse critical interest, but I am sure the presentation of the Askenasy-Dixon hypothesis is far too brief and incomplete; for the existence in plants of liquid water in a state of tension, together with the logical deductions that derive therefrom, are most fundamental to many considerations in plant physiology, and it is unfortunate that so many teachers of the subject appear to avoid venturing with their students into the analysis of these fundamental phenomena. Indeed, some specialists in physics and engineering fail to grasp the full meaning of stretched liquid water, and a few seem inclined even to deny the possibility of any such phenomenon. Texts should emphasize the inevitable importance of such things, the clear presentation of which might offer opportunities for inculcating and encouraging as much of rigid logic and the principles of controlled experimentation as is possible in a science like physiology, still so hazy with opinions and superficially reasoned hypotheses.

This book is unusually praiseworthy in that energy transformations and relations are generally considered along with material relations. The living plant is a machine that receives material and energy from

the environment, transforming them in innumerable ways and turning them out in other forms. Much emphasis is placed on the energetics of metabolism, and some consideration of the quantitative aspect of this subject is included. The author seems, however, to neglect or minimize the energy supply received by the plant, as heat from the immediate surroundings (conduction) or from more distant objects (radiation). For example (page 203): "The work done in lifting the great volume of water absorbed and evaporated by trees implies application of great quantities of energy. This energy must be liberated where it is needed, it can not well be transmitted from part to part. The intracellular release of energy, by metabolic process, chiefly oxidation in the end, furnishes a great amount of energy always available, the unused portion of which readily escapes by radiation or otherwise." It is here apparently implied that energy set free by the oxidation of substances in the plant body is supposed to play a considerable part in maintaining the transpiration stream. I do not find adequate consideration of the very large amounts of heat absorbed as such from the surroundings and available for catalyzed endothermic processes in general—such, for instance, as transpirational evaporation and the resultant entrance and upward flow of water. There seems to be no doubt that most of the energy used in raising water up the plant stem is thus derived directly from the surroundings, largely by conduction but to some extent by radiation, much as is the energy used in keeping the water of a teakettle in ebullition or in melting the ice in a household refrigerator. It is certain that energy from exothermic chemical changes in the plant takes part in many processes (*e.g.*, in active secretion when and where the latter occurs), but the total amount of energy thus derived and utilized must be very small in comparison with the amount received as heat from the surroundings. At any rate, I do not think we need to resort to respiration as a source of much free energy to account for the transpiration stream in general.

The expression "substance and circumstance" is repeatedly used by Professor Peirce to indicate the combination of the internal complex of influential conditions with the external complex (the environment). On the whole, his presentation seems to conform well with our present picture of the causality of plant or animal phenomena; things physiological do not happen because of influential internal conditions alone or because of influential environmental conditions alone, but because both sets or complexes of influences act simultaneously. Physiologists and other biologists are recently coming to use this conception of causality in their reasoning and experimentation and the book before us should be a help in this direction. But the time is apparently not yet here for any book to be quite clear and consistent in these things.

Professor Peirce does not wish us to go on considering fermentation and anaerobic respiration as closely related to the process usually called normal respiration. He appears to wish respiration to be defined as a process by which potential chemical energy is rendered kinetic, without at the same time producing nutritional substances, and he is troubled because fermentation processes are in many cases materially nutritional as well as energetically exothermic. The power of carnivorous plants to capture insects, to excrete proteolytic enzymes and to absorb products of the decomposition of insect bodies, whether decomposition is by enzymes from the plant itself or by those of bacteria, etc., is discussed, with the suggestion that this power may have been generally important for the ancestors of these plants in past times, although it is of little importance now. There are in this treatise relatively few examples of outspoken teleological thinking, though "functions" and "uses" and "benefits" are sometimes encountered in the usual manner and the story of causal relations is in some instances a bit befogged by apparent implication that things may happen in plants in order that specific results may be attained. The following sentences from page 75 constitute, however, a very real concession to the rational consideration of causality and the antecedent or etiological control of processes. Owing to their wide distribution, chemical reactions, and diverse duration, the ecologist finds it hard to assign any single function to these pigments [anthocyanins], and the physiologist may well entertain the idea in this connection, as in many others, that substances are formed or things are done just because they can be, not because they are indispensable or of any especial advantage. Indeed, even the speculative naturalist should accept such a hypothesis. . . ." From this really progressive "can-be" philosophy it may perhaps be but a short step to the "must-be" that characterizes the determinism of non-biological science and even of the experimental and practical aspects of physiology. With the meaning of "adaptation" in organisms our author has gone further, even to the logical limit, as this sentence from his introduction and many other statements unquestionably indicate: "They [organisms] are said to be 'adapted' to their environment; but it is difficult to see that they are any more adapted to their environment than is a crystal of common salt, which forms or not, which grows or disappears, according to its environment, and in its own way, peculiar to, and characteristic of the material of which it consists."

There is no intended implication of vitalism anywhere, I think, nor of purposeful processes in plants.

Perhaps the most characteristic features of Professor Peirce's volume are its conversationally critical style and mode of presentation as has been indicated, but it will specially attract the reader not only through its personal tone but also through repeated emphasis on the importance of plant physiology in the every-day affairs of human life and through the many examples drawn from the out-of-doors. "It behooves us, therefore, as citizens as well as physiologists, to investigate the processes of food manufacture, and, if we can, throw new light on the problem of world-old hunger" (page 43). Many applications of plant physiological science in agriculture, horticulture and forestry receive much attention, but the point of view of the philosophical scientist is everywhere kept to the fore.

Two chapters (pages 223–296) are devoted to irritability and most of the discussion of growth is there given. Discussion of growth in the abstract is purposely omitted, for the author says he is unable to conceive of growth as a physiological process apart from the influences to which the organism is subject (preface). These influences are classified as mechanical, chemical and radiant, and the discussion of them is full of originality. Although many of what most workers in this field would regard as important features of our knowledge of plant growth and plant response to environmental changes or asymmetry are omitted or receive but cursory mention, and although some philosophical hypotheses with relatively little direct experimental evidence are suggested, yet the examples and illustrations of the various formative and tropistic phenomena are ingeniously and interestingly chosen and discussed. The formative influences of mechanical pressures (such as those occasioned by gravitation) are presented in a novel way, with special reference to such asymmetrical thickenings as occur in tree branches, annual rings, etc. It is pointed out that pressure and contact stimuli may depend not only upon the mass pressures involved and their fluctuations, but also upon molecular pressures due to adhesion (or cohesion) forces operating where two different bodies are in contact. This part of the book should be very valuable and stimulating to somewhat advanced workers on plant responses.

The volume ends with a subject index, but there is no index of authors cited, and such an index would have been useful. Well-chosen and generally adequate citations are given as footnotes throughout the book. There are no drawings, diagrams or figures of any kind.

BURTON E. LIVINGSTON

DESERT LABORATORY,
AUGUST, 1926

## SCIENTIFIC APPARATUS AND LABORATORY METHODS

### A SIMPLE METHOD OF USING SAFETY RAZOR BLADES FOR MICROTOME SECTIONS

A NUMBER of devices designed to grip safety razor blades in such a manner that they can be used as a substitute for microtome knives are supplied by apparatus dealers. Some workers find them entirely satisfactory for small objects imbedded in paraffin, while others are unable to use them at all. The common defect is a tendency for the wafer-like blades to vibrate, particularly when sectioning large and hard objects. Moreover, they can not be used for sectioning objects imbedded in celloidin or for woody stems, roots, etc., which are commonly sectioned without imbedding by means of a sliding microtome.

The writer finds that safety razor blades can be firmly attached to the flat surface of ordinary microtome knives by means of a film of paraffin. Vibration does not occur even when cutting large blocks of hard tissues and if the blade be attached to a shanked knife, sections of celloidin blocks or of stems can be cut with a sliding microtome. The method described below is that followed when paraffin is used as the adhesive. It is possible that shellac would be more convenient.

Shanked knives of Walb or Lenz manufacture are very satisfactory, as the lower surface is flat or only slightly hollow ground and they may be used with either rotary or sliding microtomes. A thin film of melted paraffin is spread over the area to which the blade is to be attached. Care should be taken to avoid excess. The paraffin should be of a high melt point. As soon as the film has cooled a safety razor blade is laid upon it so that it projects beyond the edge of the knife by the width of its own bevel. It should be held firmly in place with cover glass forceps or suitable spring clips, while the back of the knife is passed in and out of a flame until the paraffin melts. It should then be plunged into cold water and left until completely cool. If the heating be done carefully there is no danger of damaging either knife or blade. The knife should be tilted slightly so that the molten paraffin does not flow along the edge of the blade. When clamped in the microtome, the blade should be on the side of the knife toward the object.

Gillette blades are less satisfactory than heavier blades, such as Auto-Strop, Durham-Duplex, Enders and Keen-Kutter, partly because they are so thin that they may vibrate if used on large blocks and partly because they are seldom perfectly flat, hence do not lie in complete contact with the knife. The greater length of the Durham-Duplex blade makes it more satisfactory for objects imbedded in celloidin, but its

wide bevel causes it to be somewhat too flexible for hard objects imbedded in paraffin. There are a number of stropping devices on the market which will prepare any of the blades mentioned above for sectioning. Twin-plex stroppers are very satisfactory and models are available for all types of blades. The Spiro stropper, made by John Watts, Sheffield, England, is very well constructed and convenient to use, although the claim made for it that the stroke is diagonal is not justified. Watts manufactures blades for use in Auto-strop razors which are perforated so that they can be sharpened with the Spiro stropper.

ROBERT A. NESBIT
U. S. BUREAU OF FISHERIES

## ESTIMATION OF THE COLLOIDAL MATERIAL IN SOILS

IN conducting investigations to devise methods for determining the content of colloidal material in soils, one of the methods that has been tried and has proved most successful is the hydrometer method. By means of this method, the colloidal content of a soil can be estimated quite accurately in only fifteen minutes. The general procedure consists of dispersing in a mortar by means of a pestle 50 grams of soil, placing it in a high cylinder, adding a total volume of water equal to 1,050 cc, shaking the mixture vigorously for about two minutes and then placing a hydrometer in the mixture and measuring the density or grams per liter. It has been found that the percentage of the material, based on the original sample taken, that stays in suspension at the end of fifteen minutes is equal to the percentage of the colloids as found by the heat of wetting method. This remarkable relationship is almost incredible, but it has been actually found to hold true in all kinds of soils, ranging from sandy loams to very heavy clays and even when different proportions of soil samples are used. The only places where the relationship between the percentage of material staying in suspension at end of fifteen minutes in a liter of water and the percentage of colloids as determined by the heat of wetting method does not hold very close is in abnormal soils which refuse to stay dispersed and in soils whose organic matter is not completely decomposed. Out of thirty-one soils used, however, only three refused to give a very close relationship. In the other soils the relationship is identical in many cases, and in the others it is only about 3 per cent. apart.

From the work thus far done it appears that the hydrometer method can be used confidently to estimate the colloidal content of soils quite close. In some unusual soils the estimated amount may be about 10 per cent. off of the true amount or the amount shown by the heat of wetting method, but when it is considered that by our present methods it takes almost one week to determine the colloidal content of a soil, any method that can give in fifteen minutes the colloidal content of soil should be considered very valuable, even though in some cases the results may be about 10 per cent. off.

The hydrometer method is able not only to estimate the colloidal content of soils, but also to measure the rate of settling, from which a distribution curve of the soil particles of various sizes may be worked out.

The hydrometer employed is of a lactodensimeter type, which has a large volume and weight, both of which make it very sensitive. It was calibrated to read directly in grams of material per liter of water.

A detailed report of these investigations is being published elsewhere.

GEORGE JOHN BOUYOUCOS
MICHIGAN AGRICULTURAL EXPERIMENT STATION

## PERMANENT CULTURES

VERY frequently instructors are required to keep Protozoan cultures over long periods of time. The following method has been used with great success for such cultures as paramecia, the smaller forms of amoeba and certain forms of flagellates.

A large number of hay infusions are started in ordinary drinking tumblers, using pond water from different localities. They are then placed in various positions about the room and examined from time to time until the proper culture has been found. When a desired culture is found it should be fed five or six scrapings of dried whole wheat bread. These scrapings are made by simply taking a scalpel and scraping a crust of bread, care being taken so as to feed only what the culture will utilize. The glasses are then covered and the process repeated every two weeks or so. Whole wheat bread is far superior to ordinary wheat bread.

Using the above method I have kept ordinary classroom cultures alive for a period of a year.

It is also excellent for maintaining such cultures as rotifers and the small crustaceans.

FREDERICK BAUER
RHODE ISLAND STATE COLLEGE

# SPECIAL ARTICLES

## THE FILTERABLE CELL OF THE ROUS CHICKEN SARCOMA AND THE QUESTION OF THE CAUSATIVE AGENT

IN a previous note[1] I reported that desiccated or glycerinated tissues of the Rous chicken sarcoma No. 1 often contain many viable cells. The bearing of this observation on the question of the so-called causative agent which has long been supposed to exist in this

[1] Nakahara, W., SCIENCE, 1926, LXIII, 549.

class of tumors is obvious, for the hypothesis of such an agent depended entirely upon the freedom from living cell of the desiccated, glycerinated or filtered tissue, by which these sarcomas can be transmitted. These materials had been inferred to be free from viable cells on the basis of the impossibility of transmitting mammalian tumors by the similarly treated material, thus giving rise to the belief in the existence in avian sarcomas of some entity which is separable from sarcoma cells. It would seem not impossible that some fundamental differences which might exist between the cells of the peculiar avian sarcomas and the cells of mammalian neoplasms might well account for the differences in their transmissibility, yet this point has scarcely been considered.

The purpose of this note is to show that the last of the three evidences, namely, the filterability, is also of no essential value in supporting the hypothesis of the causative agent. For a detailed description of the experiments the reader is referred to my article in *Gann*, vol. XX, No. 2, June, 1926, the journal of the Japanese Society of Cancer Research.

At first sight it would seem quite impossible that a cell of a higher animal should pass through a bacteria-tight filter. It must be admitted, however, that a soft, jelly-like cell, even much larger than bacteria, might readily "stream" through the pores of the filter when filtered under negative pressures, as is usually done. It was felt that such might indeed be the case with the Rous sarcoma No. 1, because of the frequent occurrence in this tumor of very minute cells, measuring 1.5 x 1.5 to 2.5 micra in sections fixed in formalin. Filtration experiments showed that a similar type of minute cells *do* pass through Berkefeld filters, V and N.

The usual method of filtration was followed, using, however, distilled water instead of physiological solution for suspending the mashed tumor tissue. Berkefeld filters were proved to be bacteria-tight by previous or simultaneous tests with *Bacillus prodigiosus*. About 10 cc of the clear filtrate was centrifugated at a high speed for half-an-hour, smear preparations were made of the bottom portion of the fluid and the stained smears were then carefully examined. Some minute but intact cells were demonstrated in this manner in three out of five different tumor filtrates through Berkefeld V candle, and in three out of seven filtrates through the N candle.

The cells found in the smears of filtrates measured on an average about 2.5 x 3 micra. They have round or oblong, well-stained nuclei, which are often surrounded by a small halo. The cytoplasm stains pale blue with Giemsa solution and usually shows what appear to be minute ameboid processes.

As the consequence of the invalidation of all the experimental foundations upon which the hypothetical causative agent is based, the chicken sarcoma can now be considered on a level with the true neoplasms of mammals. The retention of the identical histological characteristics by the avian tumors through their various processes of transmission (by desiccated material, by filtrates, etc.) can now be most satisfactorily explained as being due to the actual transplantation of sarcoma cells.

The recent work of Gye and Andrews[2] demonstrates that the filterability of the Rous sarcoma No. 1 varies from generation to generation during transplantation, filterable tumors giving rise to non-filterable ones, and *vice versa*. This observation, as the British authors state, must bring about a serious consequence on the filterable agent as the essential cause of the growth. From the recognition of the filterable cell, the variation in the filterability can be readily explained on the basis of the well-known cellular polymorphism of the Rous sarcoma.

### CONCLUSION

The demonstration of filterable cells which frequently occur in the Rous sarcoma No. 1 renders it impossible to accept Berkefeld filtrates as being cell-free. This fact, taken together with the extraordinary resistance of sarcoma cells to desiccation and glycerination previously reported, may be regarded as removing completely the necessity for assuming the existence of the so-called filterable causative agent.

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## GLASS AS A FOURTH STATE OF MATTER

IN the past a glass has been generally considered to be simply a super-cooled liquid. As a consequence, the transition between the glassy and liquid states has been imagined as gradual and continuous. This is by no means the case, however, as recent studies on both inorganic and organic glasses[1] have demonstrated. With n-propyl alcohol, for instance, the softening or "melting" of the glass takes place rather sharply within the temperature interval 90°–102° K.

[2] Gye, W. E., and Andrews, C. N., *Brit. J. Exp. Path.*, 1926, VII, 81.

[1] A number of inorganic glasses have been studied qualitatively by Tool and Volasek, U. S. Bureau of Standards Scientific Papers, *15*, 537 (1919). In the case of several organic glasses the specific heat-temperature curve has been worked out quantitatively: n-propyl alcohol by Gibson, Parks and Latimer, *J. Am. Chem. Soc.*, *42*, 1547 (1920), and more recently by the present authors in an unpublished investigation; glycerol by Gibson and Giauque, *J. Am. Chem. Soc.*, *45*, 94 (1923), and ethyl alcohol by Parks, *ibid.*, *47*, 338 (1925).

and there is an abrupt 80 per cent. increase in heat capacity during the process, as the accompanying figure shows. In fact, the heat capacity reaches a maximum in this softening region and then falls off slightly as the substance becomes distinctly liquid at higher temperatures. Qualitative observations which we have made indicate that the volume of the alcohol also increases sharply in the transition process and it seems almost certain that other properties will likewise exhibit discontinuities in this region.

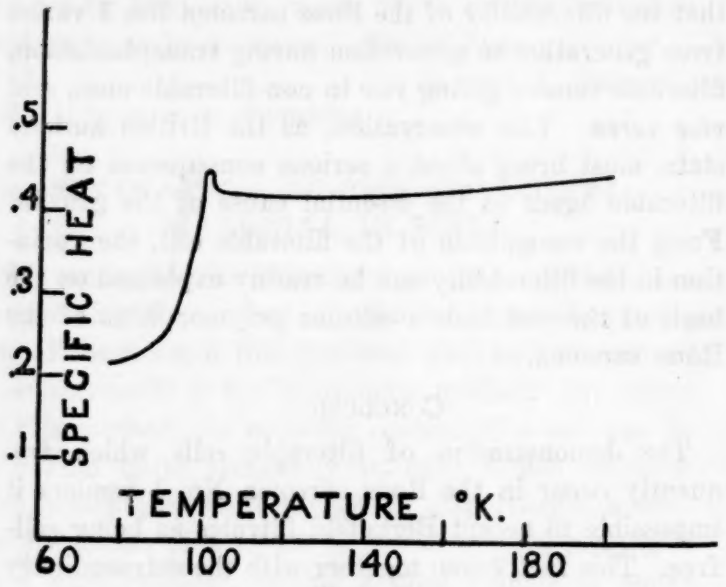


FIG. 1

In view of these considerations, it would seem reasonable to regard glass as a fourth state of matter, distinct from the liquid and crystalline states, and yet showing to some extent characteristics of both these states. A liquid is characterized by a random, haphazard arrangement of its component molecules or units and by the existence of variable, mobile bonds between these units; while a crystal possesses a definite, orderly structure and is held together by tight, rigid bonds. A glass, like a liquid, possesses a random arrangement of its units; on the other hand, like a crystalline substance, it is held together by a fixed, rigid bonding between these component particles. Because they are alike in this latter respect, the glass and crystalline states have nearly the same heat capacity. Furthermore, the comparatively large heat absorption in the case of the glass during the softening process is analogous to the heat of fusion in the melting of a crystalline material; in both cases the energy is required for breaking fixed, rigid bonds. On the other hand, because of its irregular, random structure these bonds in the case of a glass vary in strength and therefore do not all lose rigidity at exactly the same temperature; hence the "melting" of a glass is not sharp and invariable as in the case of a crystal.

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## THE DIVISION OF CHEMICAL EDUCATION OF THE AMERICAN CHEMICAL SOCIETY

THE opening session at the Philadelphia meeting was devoted to a symposium on International Chemical Education. Professor Ernst Cohen outlined the system of graduate study in European universities and called attention to some points in which improvement may be made in the American practice. Dr. P. E. Verkade explained the system of education in Holland by which students are trained for graduate work in the universities. Dr. Neil E. Gordon gave an illustrated review of the graduate work done in various countries of Europe. He urged the adoption of a number of international exchange fellowships, from which great benefit should result on both sides of the Atlantic. Dr. Harry N. Holmes called attention to the necessity of knowing French and German and gave many interesting personal touches in his recent study of chemical education in Europe.

A half day of miscellaneous papers presented many helpful suggestions to the teacher of chemistry. The most outstanding factor in this group was a series of four papers on various types of visual education. These were illustrated by charts, drawings, lantern slides and motion pictures. Another very helpful paper gave many suggestions on the proper way for chemists to cooperate in securing publicity for their own work and for the science itself.

One session was devoted to a joint discussion with the Division of Industrial and Engineering Chemistry and the Committee on Chemical Engineering Education on the topic "What is Chemical Engineering?" Dr. E. R. Weidlein presided and the discussion was led by Dr. Charles L. Reese and Dr. Harry A. Curtis. At the conclusion a resolution was adopted calling for a continuation of the study, with an extension to include the general curricula to be represented by the term "chemical engineer."

The concluding session contained papers especially designed to interest teachers of chemistry in secondary schools. Papers were read on a cooperative plan between high schools and sections of the American Chemical Society; on the vocabulary employed in high school textbooks of chemistry; on laboratory instruction in chemistry; and on vocational guidance in secondary schools as a training for a career in chemical industries.

The following officers were elected for the ensuing year: Chairman, B. S. Hopkins; vice-chairman, G. W. Sears; secretary, Ross A. Baker; members of the executive committee, Wilhelm Segerblom, W. D. Engle and M. V. McGill. The term of the treasurer-business manager, E. M. Billings, did not expire at this time.

B. S. HOPKINS,
*Secretary*